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MASCHINENFABRIK AUGSBURG-NÜRNBERG·A·G·

HYDRAULIC IRONWORK

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INTERNATIONAL

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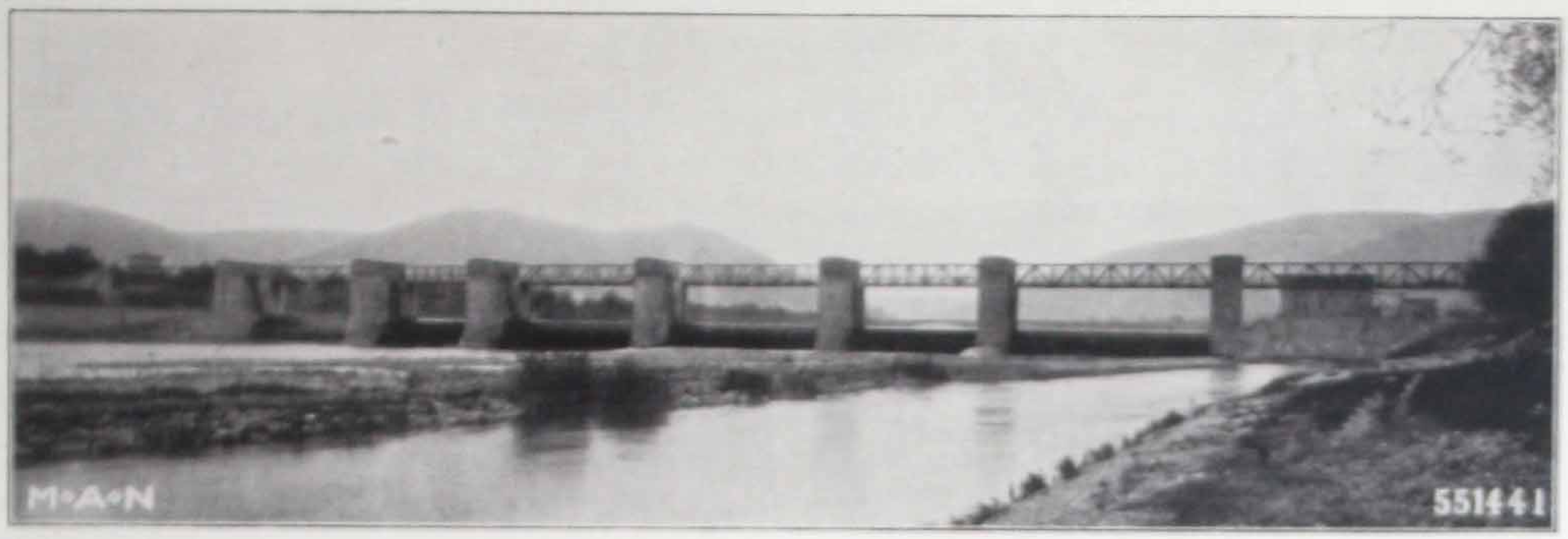


Fig. 1. Weir Plant in the Neckar river near Wieblingen (Baden).
4 M. A. N. Rollers each 88 ft. 9 in. (27,1 m) clear span and 12 ft. 10 in. (3,9 m) — (3,9 m) — 15 ft. 9 in. (4,8 m) and 18 ft. (5,5 m) damming height.
2 M. A. N. Double Sluices each of 65 ft. 9 in. (20 m) clear span and 12 ft. 10 in. (3,9 m) and 18 ft. (5,5 m) damming height.

M·A·N

MASCHINENFABRIK AUGSBURG-NÜRNBERG A·G·

Hydraulic Ironwork

Roller weirs, Sluice weirs, Bascule-, Sector-, Segment- and Drum weirs, Dock gates, Lock gates, Pneumatic foundations, High pressure pipe lines, Propeller pumps.

CONTENTS.

Introduction.

The canalization of navigable rivers, the construction of new canals and hydro-electric stations and also protective measures undertaken to provide against flood conditions in rivers, have all given rise to their special problems in regard to hydraulic iron-work. – The extensive experience gained by Messrs. M.A.N. during many years intensive study of these problems places them in a unique position for satisfactorily solving such difficulties.

As one of the oldest established manufacturers of machinery and structural work in Germany, M.A.N. during the last thirty years have been responsible for much pioneer work and numeros innovations in this field which have now been adopted as the standard practice in many countries. Comprehensive practical experience, combined with continual technical investigation, has enabled them to successfully overcome many difficult problems of hydraulic engineering and to discover the most suitable designs of structure and equipment.

Roller Weirs.

The introduction of the roller weir by the M. A. N. over 25 years ago was one of the most important advances in the progress of hydraulic engineering. The roller principle of construction permits of great strength and large diameter with, in consequence, considerable unsupported lengths, thus providing greatly increased damming heights, water spaces and areas. The closing member is a steel plate roller arranged to roll up and down inclined guides.

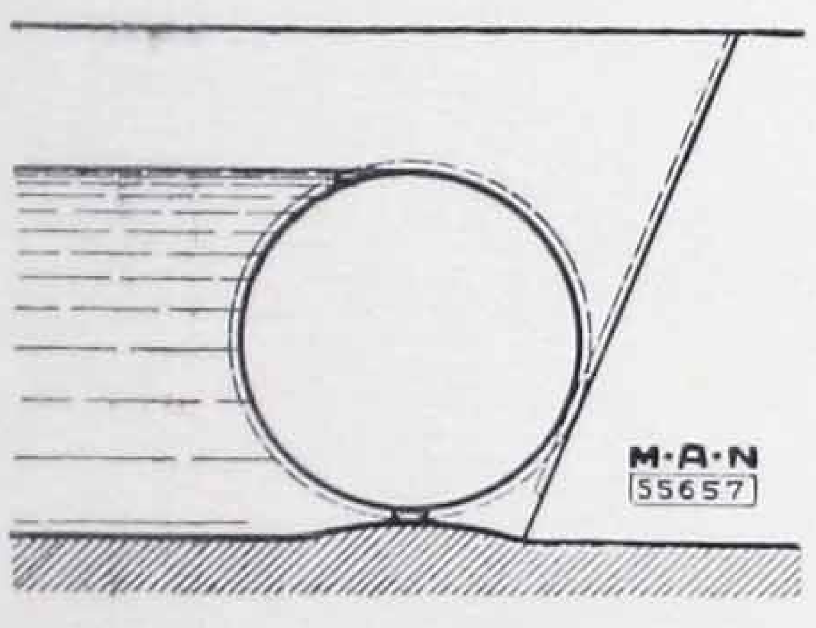


Fig. 2. Roller of cylinder shape for comparatively small damming height compared to the clear span.

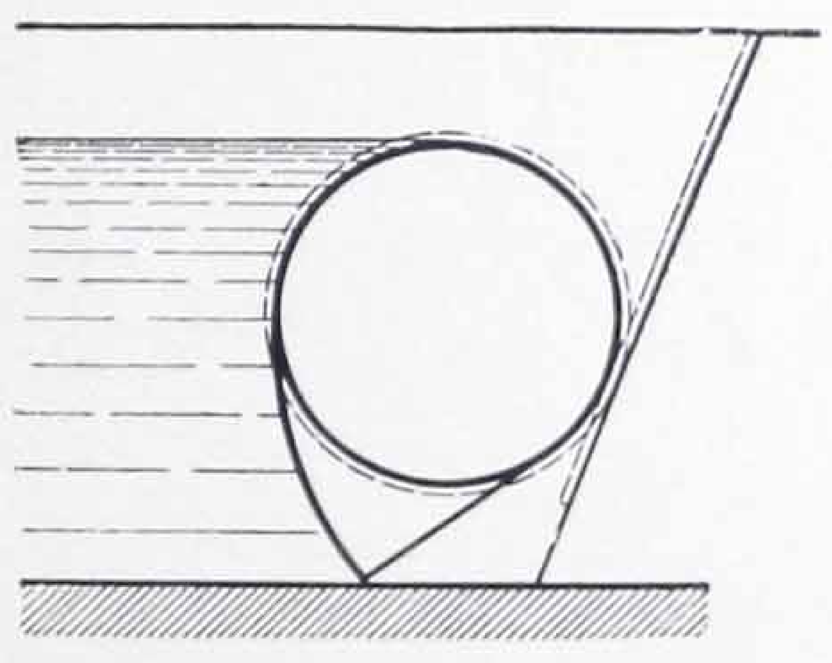


Fig. 3. Roller with "Beak" attachment for a larger damming height compared to the clear span.

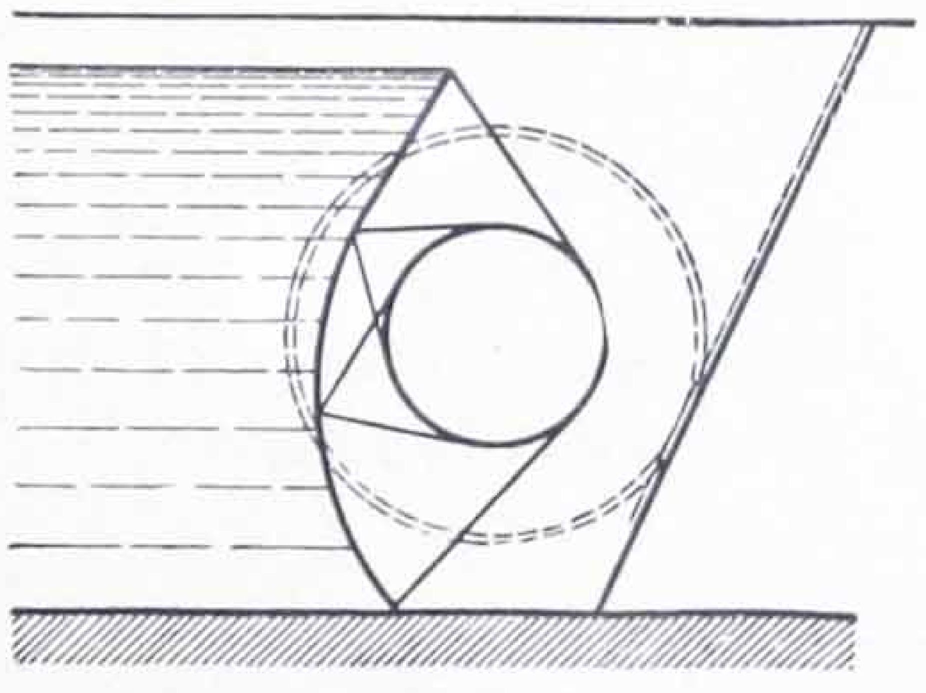


Fig. 4. Roller with damming shield for large damming height in relation to the clear span.

Advantages.

1.) Large spans between supports and great damming heights can be employed.

2.) Unaffected by sand, gravel, stones, ice, surface trash etc. For watercourses carrying much detritus and having large stones in the bed on the headwater side the roller weir affords the most satisfactory solution, as proved by their increasing adoption, even for purely power generating plants.

3.) High degree of watertightness. The sill packing is usually of timber, the side packing of small

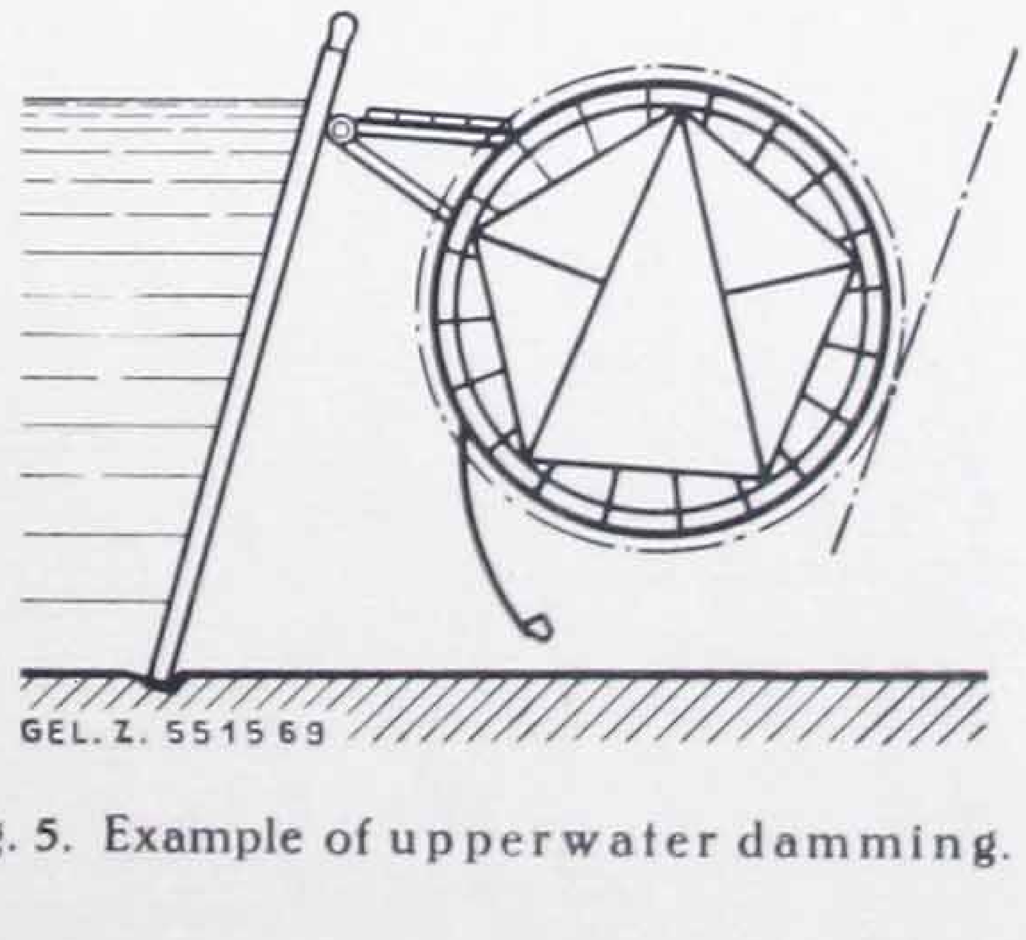


Fig. 5. Example of upperwater damming.

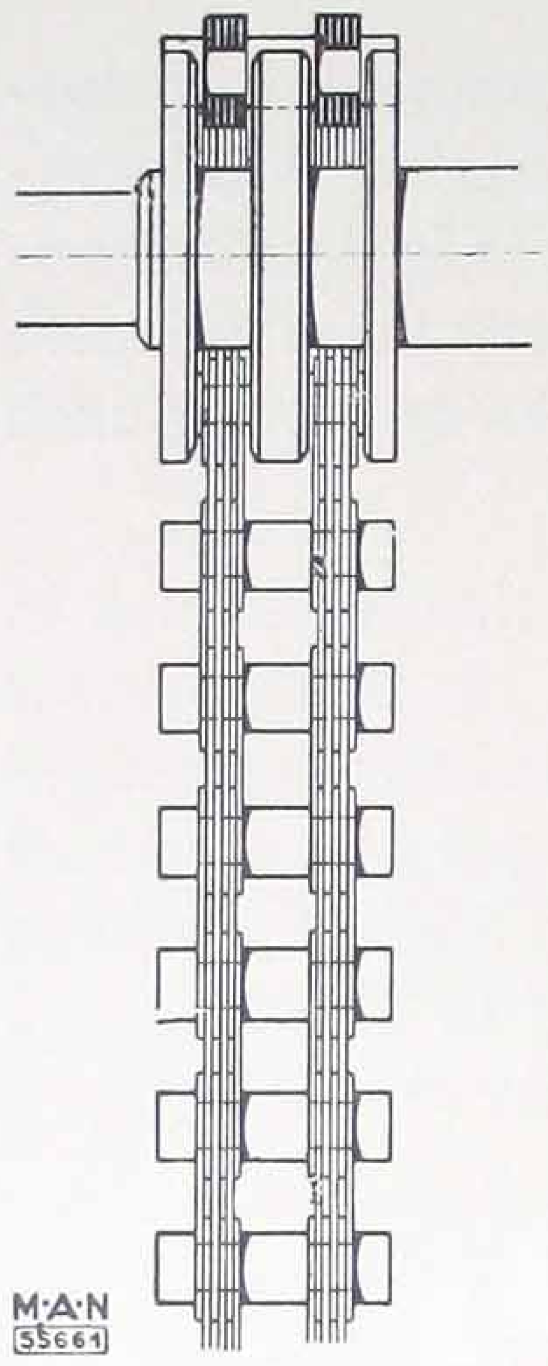


Fig. 6.
M. A. N. patent link chain with bolts working in three bearings.

metal plates rivetted in position and held fast against the masonry by the water pressure.

4.) Easy operation with small power and only single-sided drive. Operation is effected either by hand or electrically from one end of the roller. The construction prevents distortion and double ended operation can be dispensed with. The roller is raised and lowered on steeply inclined guides set in grooves in the masonry abutments by means of simple winch gear with spur wheel transmission and worm drive. The M. A. N. flat link chain with triple bearings for the pins is employed. This minimises stresses and ensures uniform and limited wear.

5.) Absolute minimum of attention, easy operation and low maintenance costs owing to extreme simplicity and robust construction.

6.) Reliability. An electro-magnetic brake which comes into operation automatically when the motor stops from any cause ensures reliable operation. A further safeguard is provided by the self-locking worm-gear.

7.) Simplicity of raising roller for painting and providing a temporary dam meanwhile.

8.) Easy maintenance of winter working by electric heating. For direct heating, flat iron rails are let into the grooves of the piers and heated by low-tension current. For indirect heating cast or wrought iron plates, having enclosed watertight channels are provided, which contain heating elements connected individually or in series, and warm up only those portions of the pier walls which are liable to ice formation.

The above advantages have resulted in such wide adoption of the roller weir that the M. A. N. have already manufactured 137 weirs of this type, involving a total of 245 rollers, the countries concerned being Germany, Sweden, Norway, Finland, America, France, Italy, Austria and Hungary.

Fig. 7.
Roller weir in the Main river near Schweinfurt (Bavaria), built 1902/03 — one of the two first roller weirs, clear span: 115 ft. (35 m), damming height: 6 ft. 7 in. (2 m) Road bridge: 59 ft. (18 m), 174 ft. (53 m), 59 ft. (18 m) spans.

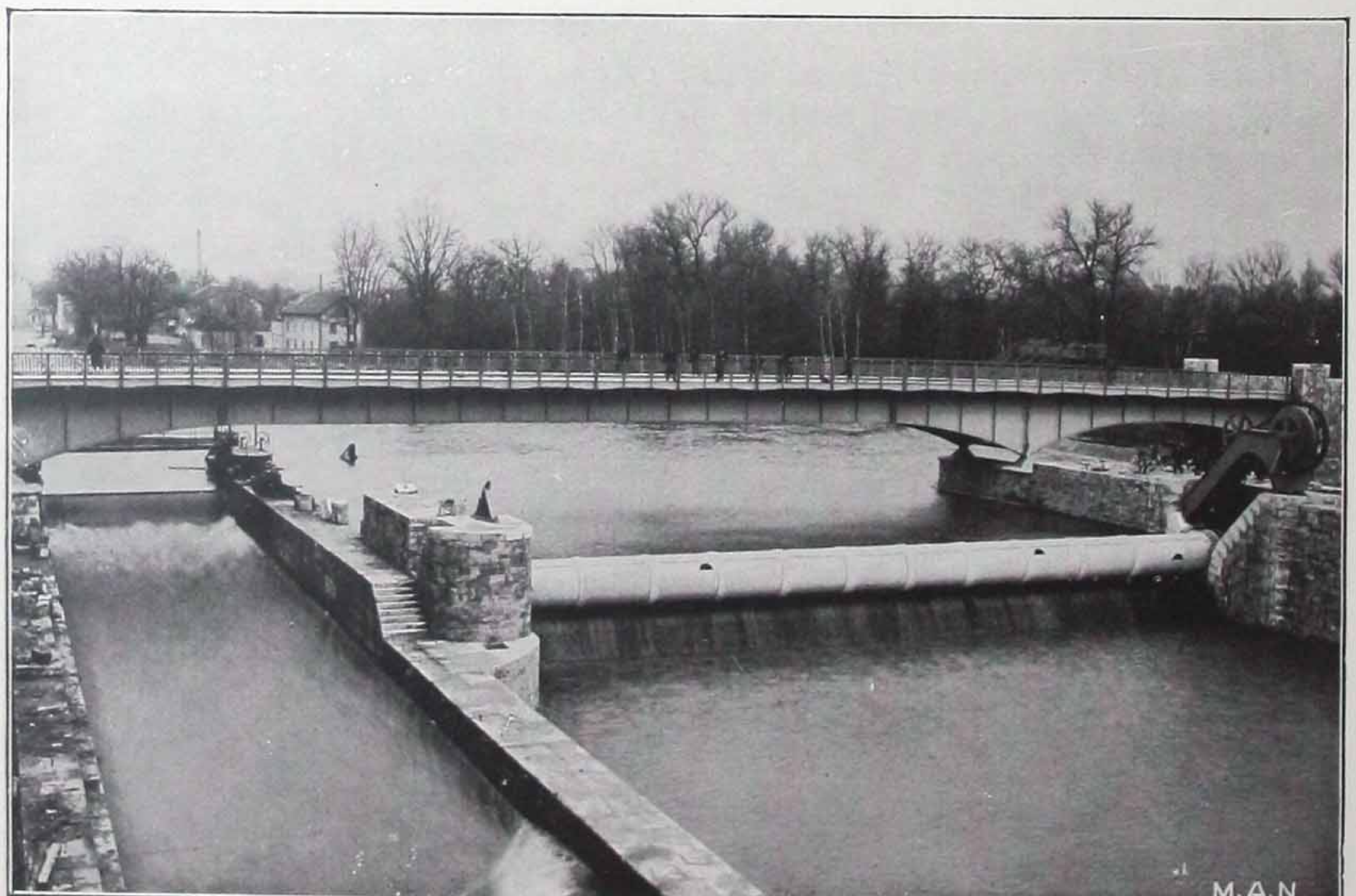
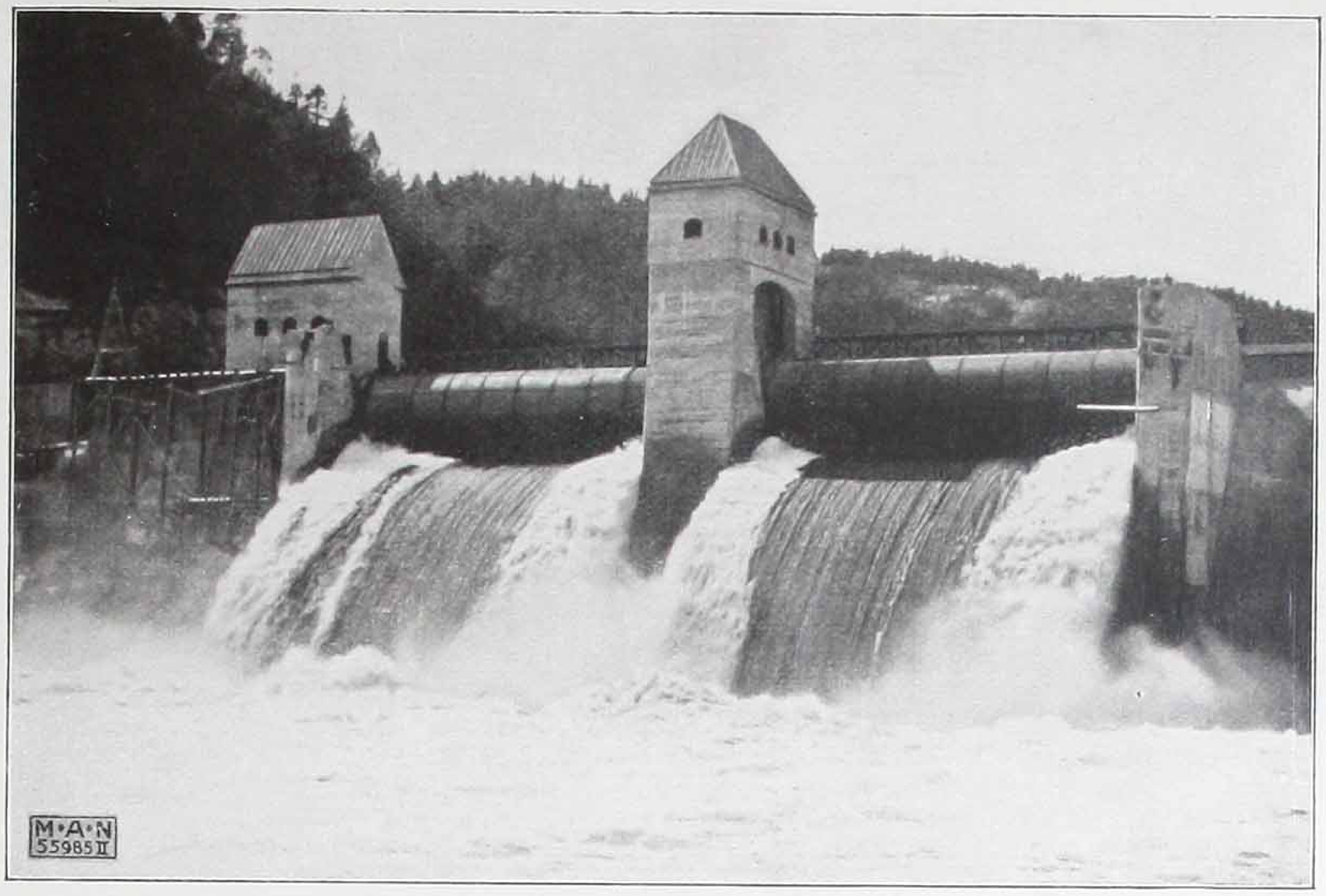


Fig. 8.
Roller weir at Nomeland (Norway), 2 rollers each of 65 ft. 9 in. (20 m) clear span and 16 ft. 5 in. (5 m) damming height.



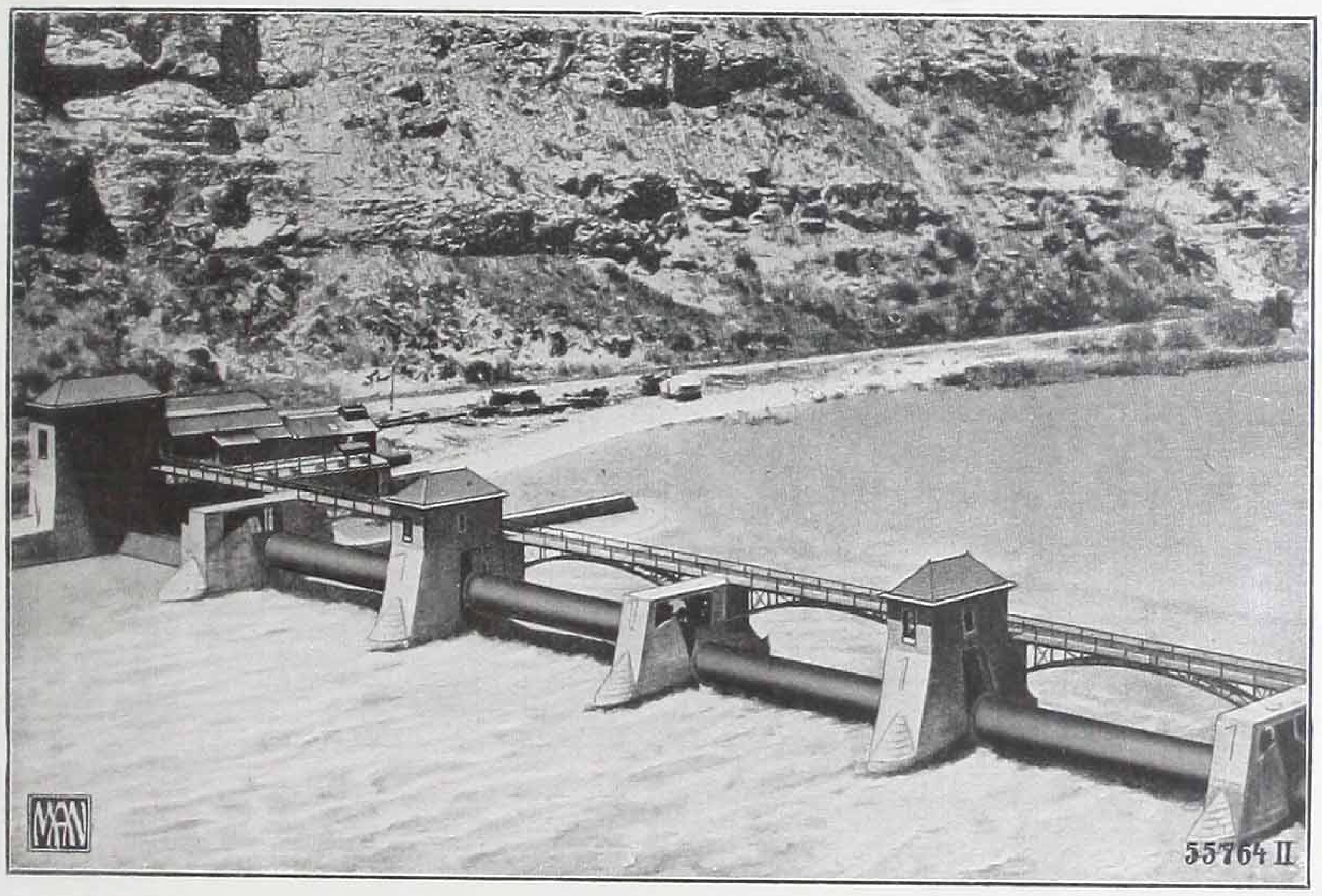
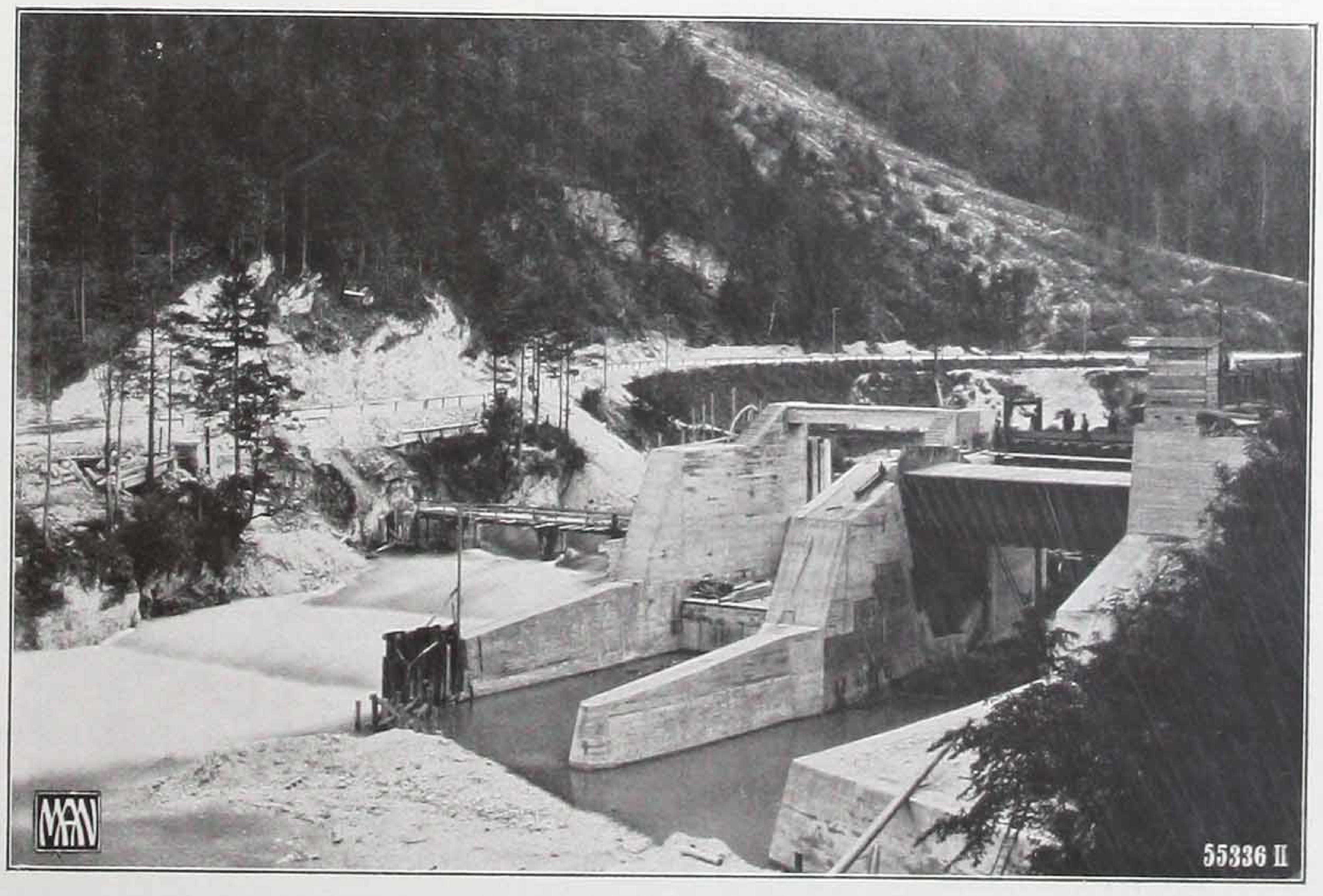


Fig. 9.
Roller weir in Grand River, Colorado (U. S. A.).
6 rollers clear spans of 70 ft. (21, 35 m), damming height 9 ft. 11 in. (3,12 m), 1 roller clear span of 60 ft. (18.3 m), damming height 15 ft. 5 in. (4,67 m). Built 1914 by United States Reclamation Service to the M. A. N. designs.

Fig. 10.
Roller weir in the Saalach river, Kibling near Reichenhall. (Saalach Power station, Bavaria). Clear span 44 ft. 7 in. (13,6 m), damming height 27 ft. 11 in. (8,5 m).



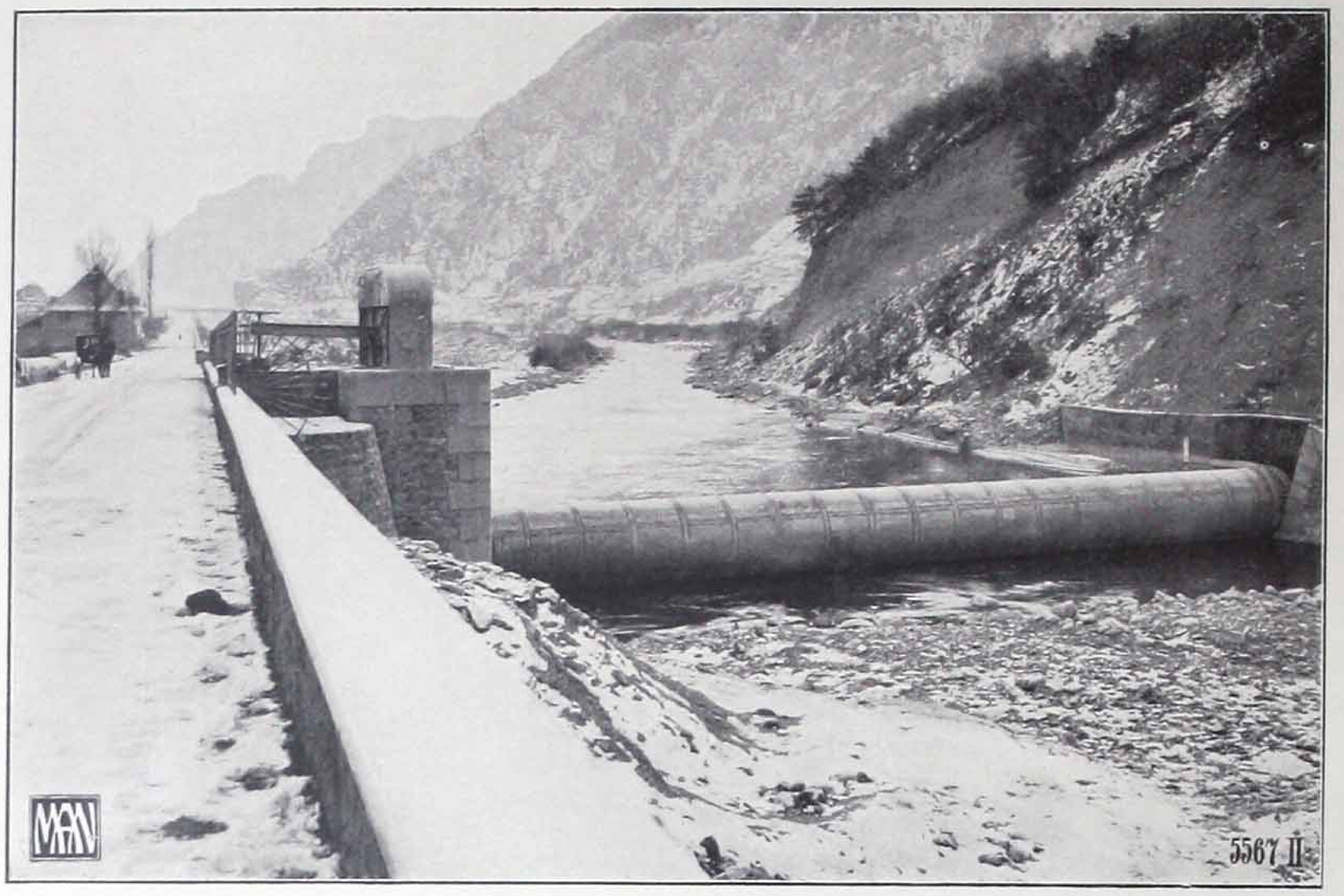


Fig. 11. Roller weir in the Arc river near St. Michel de Maurienne (Savoy).
Clear span 98 ft. 5 in. (30 m), damming height 9 ft. 10 in. (3 m).

Submersion Roller

is a modification of the above type. Besides having all its special features, it possesses the further advantage that ice and drift of all kinds can be discharged over the weir with the minimum loss of water. The water regulation with this type of roller is effected at the surface, i. e. overflow, with consequent benefit to the foundations of the weir and the river bed on the tail water side.

Although submersed, closure is effected by only one single, robust roller having a single drive and horizontal packing joint.

Special attention has been given to the sill packing. A sheet metal box or chamber (a) is located at the lower beaklike projection of the roller and engages positively with the rest of the construction. The wall of this box on the head water side consists of a sprung plate (b), rivetted at one side to the water box and carrying an oak packing beam (c) on the upper side. Through a slit above this packing beam and through water pipes (d), water enters the box and presses the sill packing beam (c) against the fixed, iron-bound crest of the weir (e).

This system was only introduced a few years ago and has proved in every way satisfactory in practice.

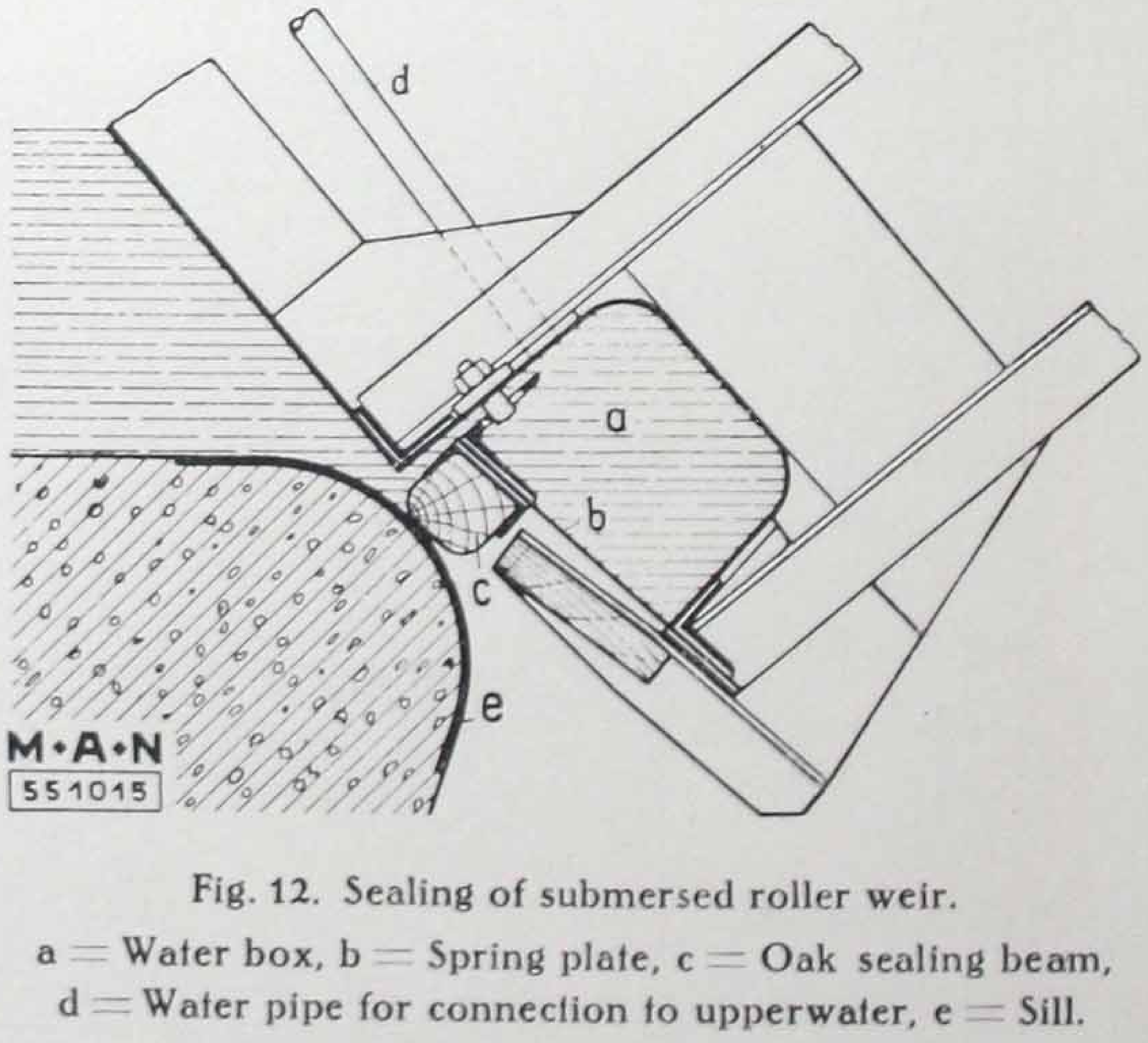


Fig. 12. Sealing of submersed roller weir.
a = Water box, b = Spring plate, c = Oak sealing beam,
d = Water pipe for connection to upperwater, e = Sill.

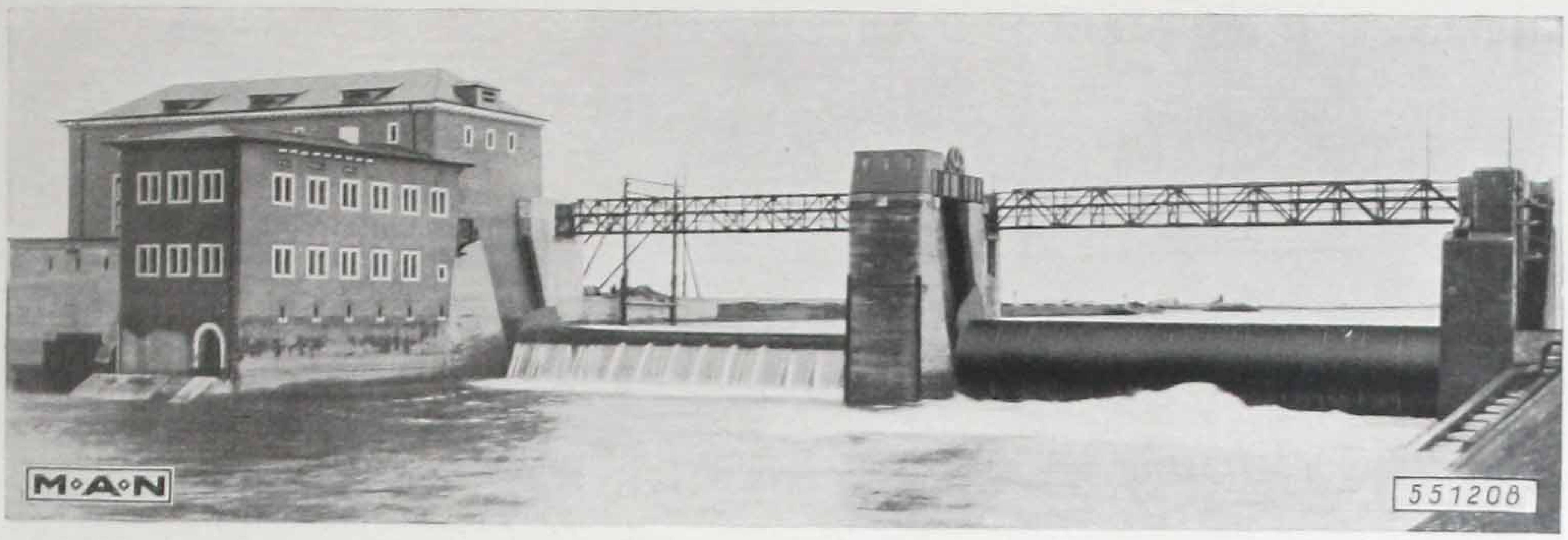


Fig. 13. Roller weir in the Main river, Viereth near Bamberg (Bavaria) for a hydro-electric power station of the Main-Rhein-Donau Shipping Co. 2 M. A. N. submersible weirs, 3 ft. 3 in. (1 m) submersible depth, clear span 98 ft. 6 in. (30 m), damming height 19 ft. 8 in. (6 m).

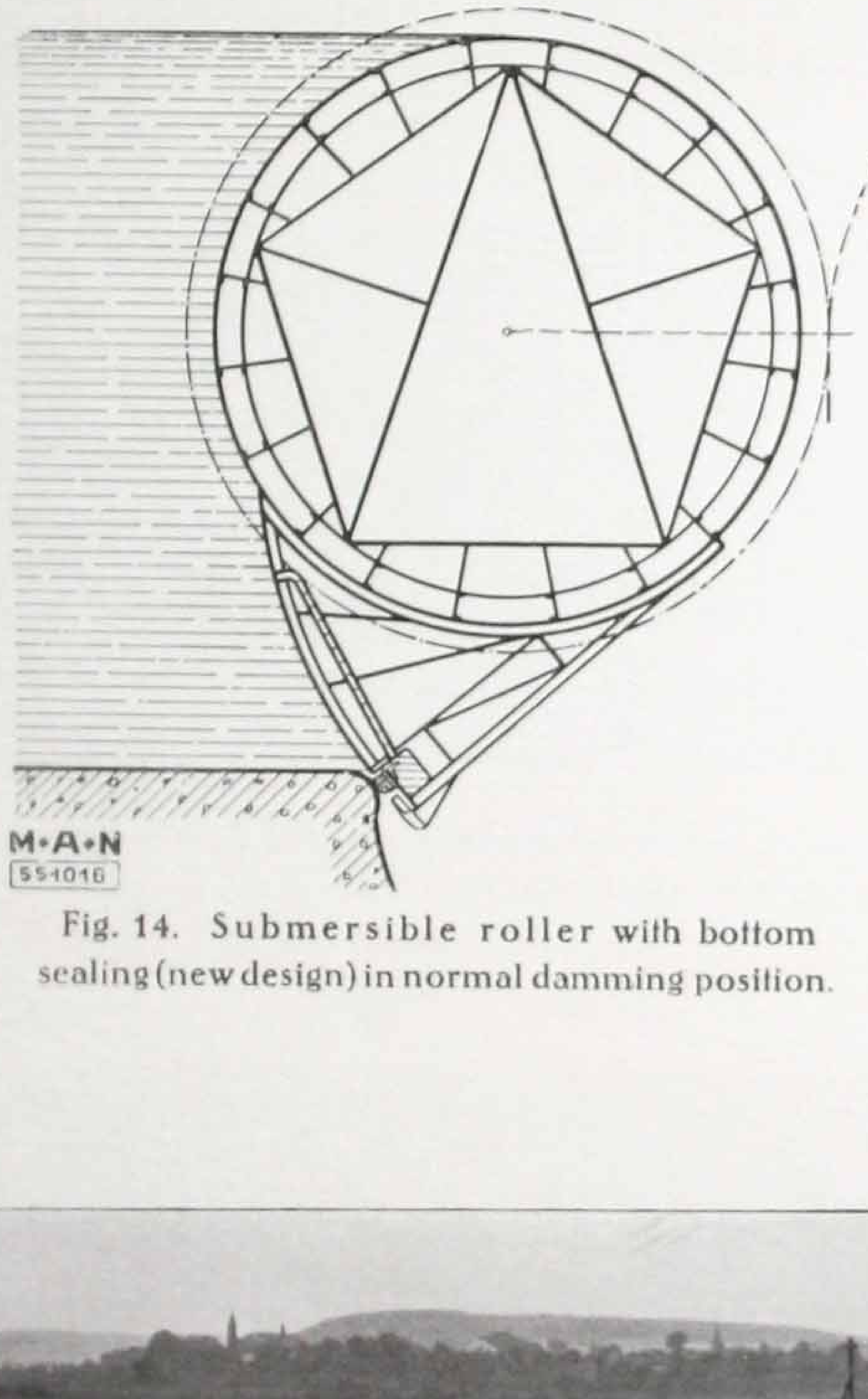


Fig. 14. Submersible roller with bottom sealing (new design) in normal damming position.

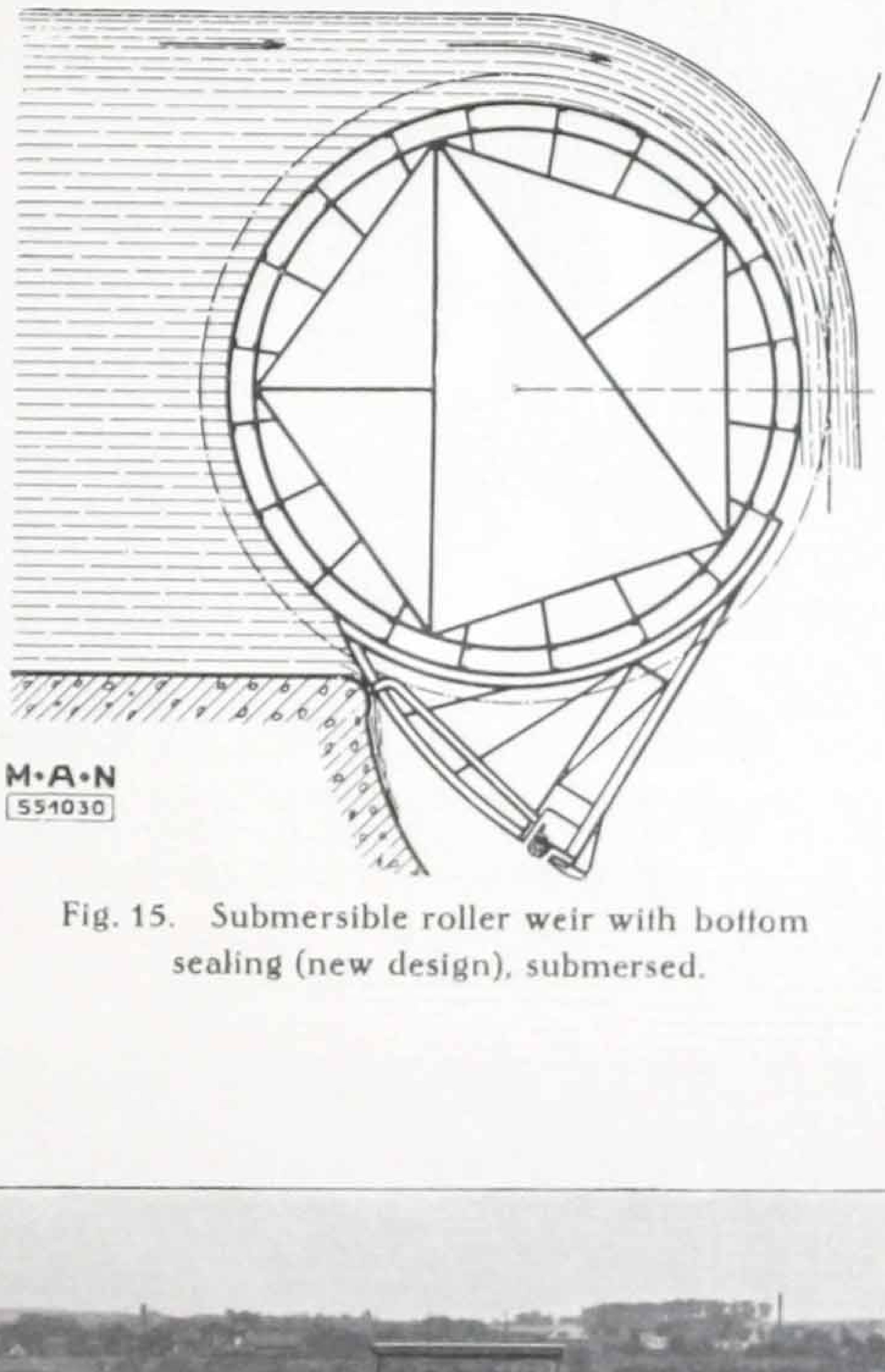


Fig. 15. Submersible roller weir with bottom sealing (new design), submersed.

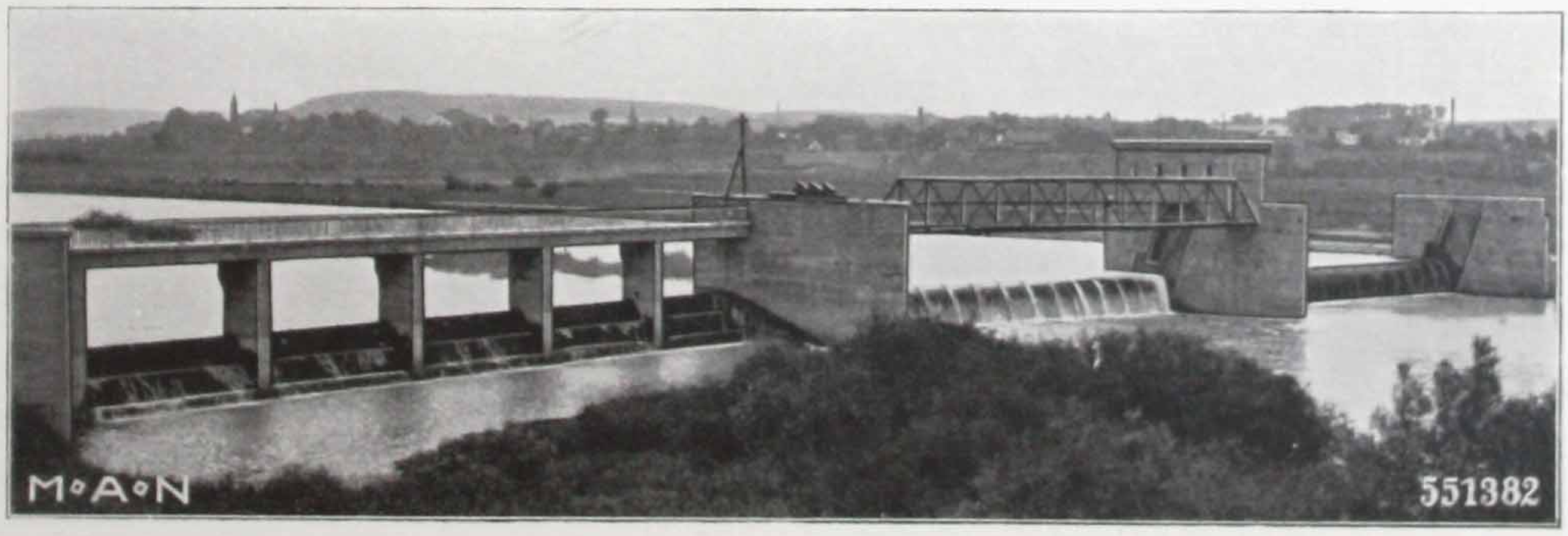


Fig. 16. Weir plant in the Ruhr river near Mulheim-Styrum (Westphalia). 2 M. A. N. submersible rollers 1 ft. 1 3/4 in. (0,35 m) submersion depth, clear span each 105 ft. (32 m), damming height 9 ft. 6 in. (2,9 m).

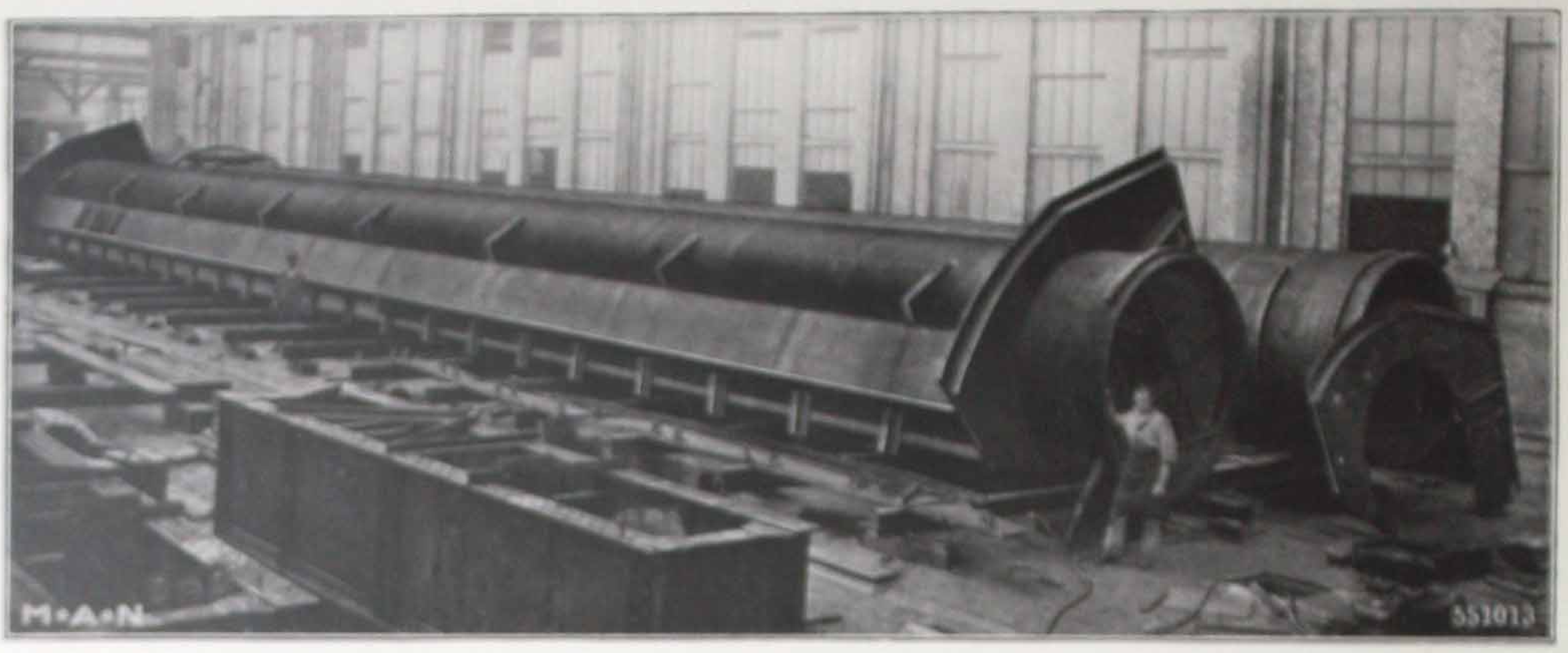


Fig. 17. M. A. N. submersible roller weir for Mulheim-Styrum during erection in M. A. N. Works Gustavsburg.

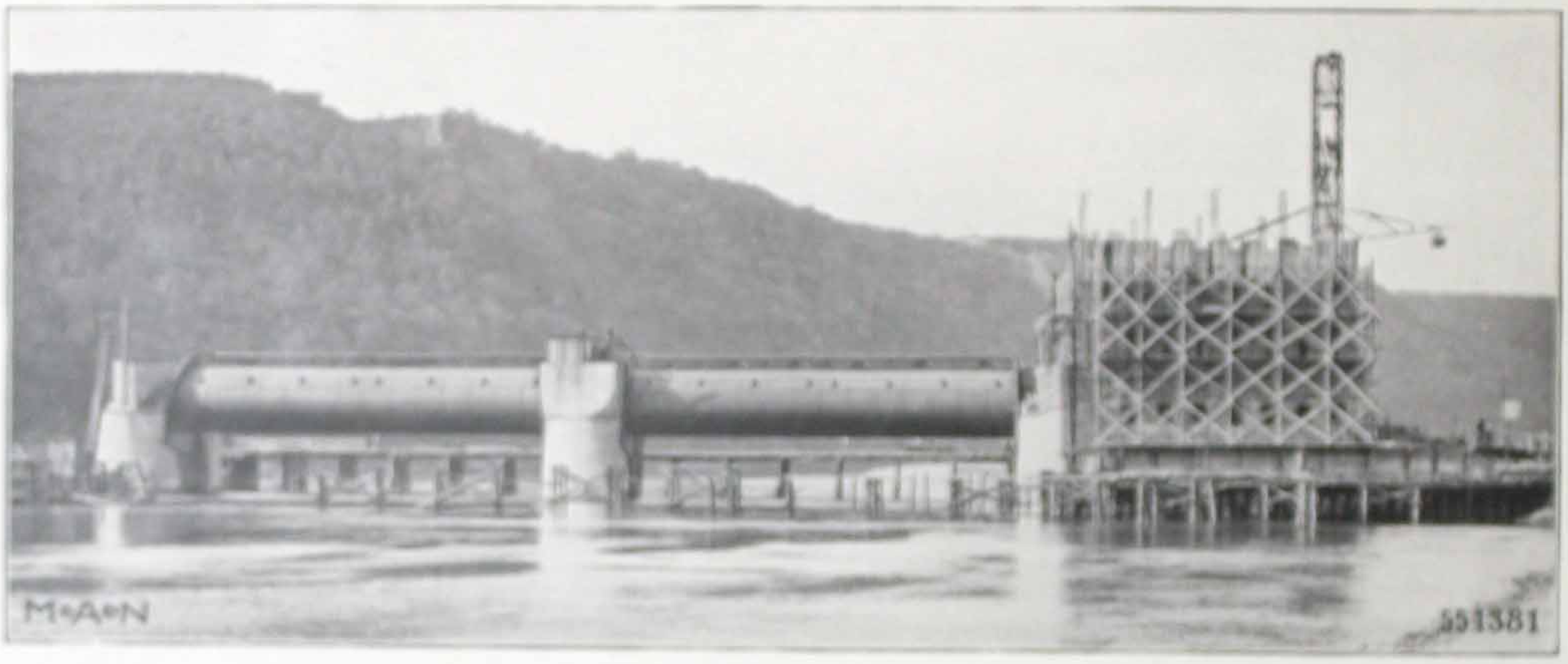


Fig. 18. Weir in the Ruhr river near Hengstey (Ruhr District). 2 M. A. N. submersible rollers 5 ft. 11 in. (1,8 m) submersion depth, clear span 98 ft. 6 in. (30 m), damming height 19 ft. 8 in. (6 m).

Fig. 19. Roller weir in the Neckar river near Reutlingen (Wurttemberg). 1 submersible roller, clear span 85 ft. 3 in. (26 m), damming height 14 ft. 9 in. (4,5 m), submersion depth 3 ft. 3 in. (1 m).

Sluice Weirs.

Sluice weirs are the oldest movable damming devices for smaller and larger openings. They are made in one or two parts. Subdivision of the height is frequently desirable in the case of power station sluices; and especially where the stream carries with it much ice and drift etc. which has to be discharged (with minimum loss of water – apart from other considerations) to protect and lengthen the working life of the fixed and movable parts of the plant. The sluices are constructed either of the sliding or roller type, depending on the working conditions and the magnitude of the water pressure.

Sliding sluices are only used for smaller openings, such as inlet canals, bottom outlets, by-pass canals, and for lock gates and intake constructions for generating stations. Either hand or electric operation can be provided.

Roller sluices are used in the case of large openings of great height, as here the resistance to movement offered by sliding sluices would be excessive and the raising gear, in consequence, too massive. With all roller sluices, the roller tracks are arranged to take the water pressure as calculated hydrostatically.

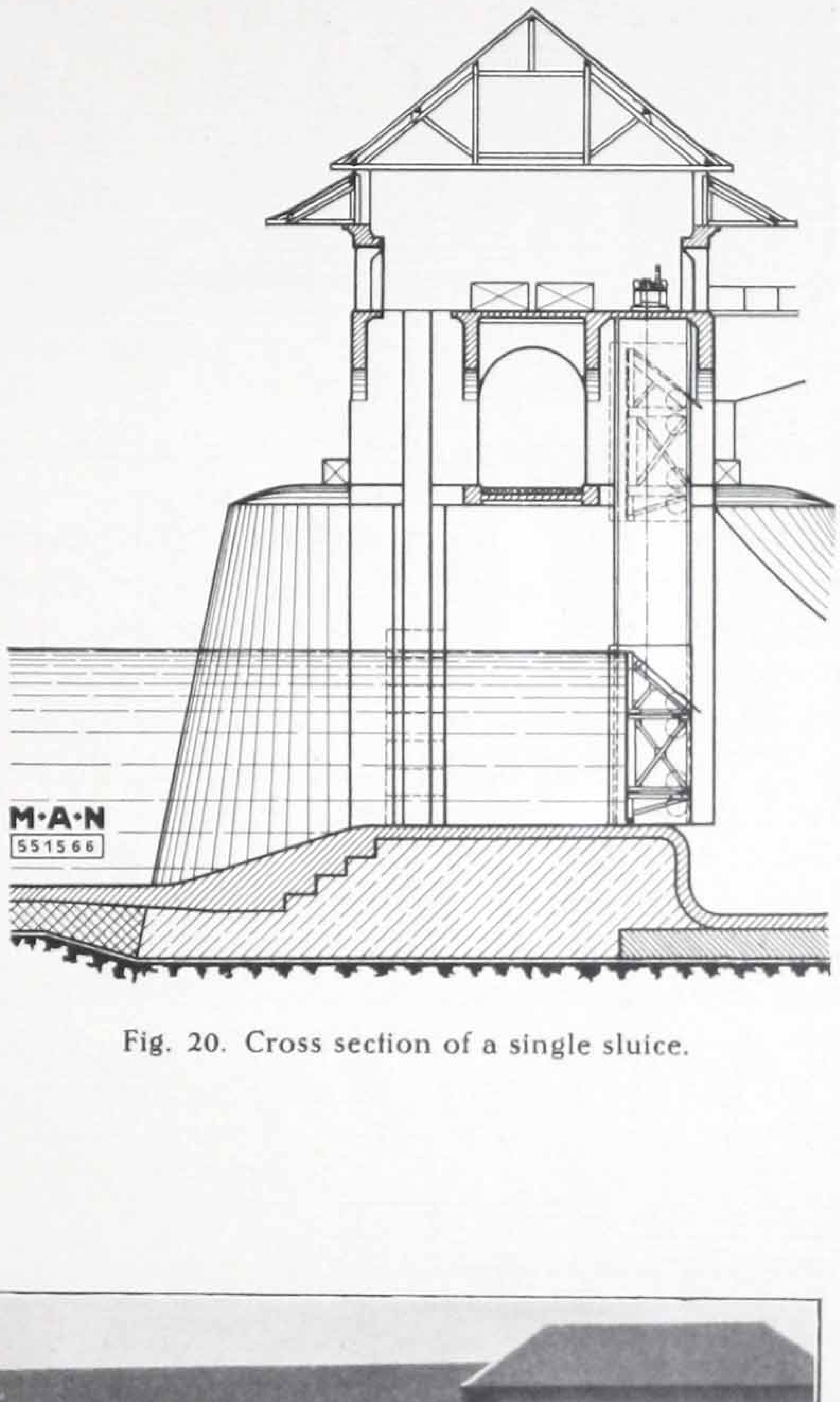


Fig. 20. Cross section of a single sluice.

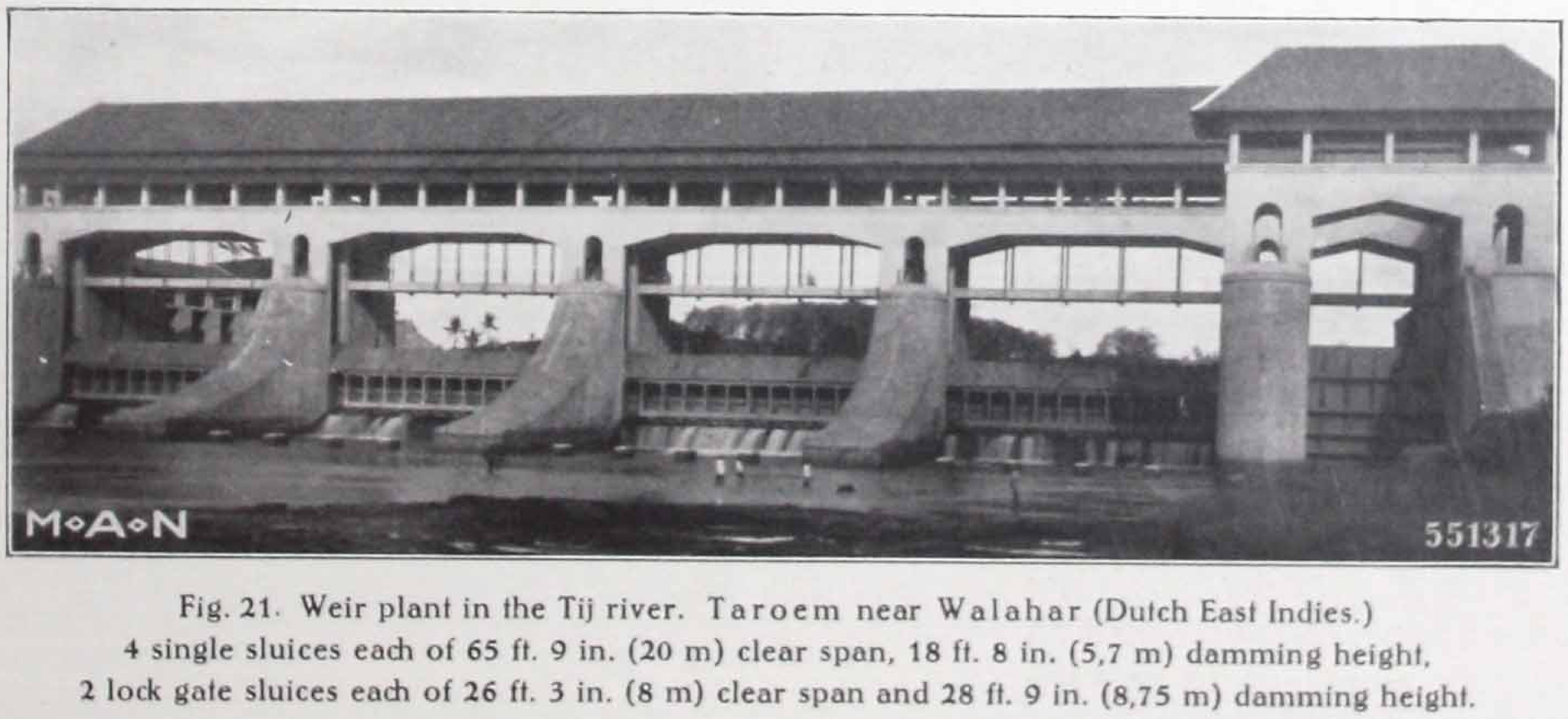


Fig. 21. Weir plant in the Tij river. Taroem near Walahar (Dutch East Indies.)
4 single sluices each of 65 ft. 9 in. (20 m) clear span, 18 ft. 8 in. (5,7 m) damming height,
2 lock gate sluices each of 26 ft. 3 in. (8 m) clear span and 28 ft. 9 in. (8,75 m) damming height.

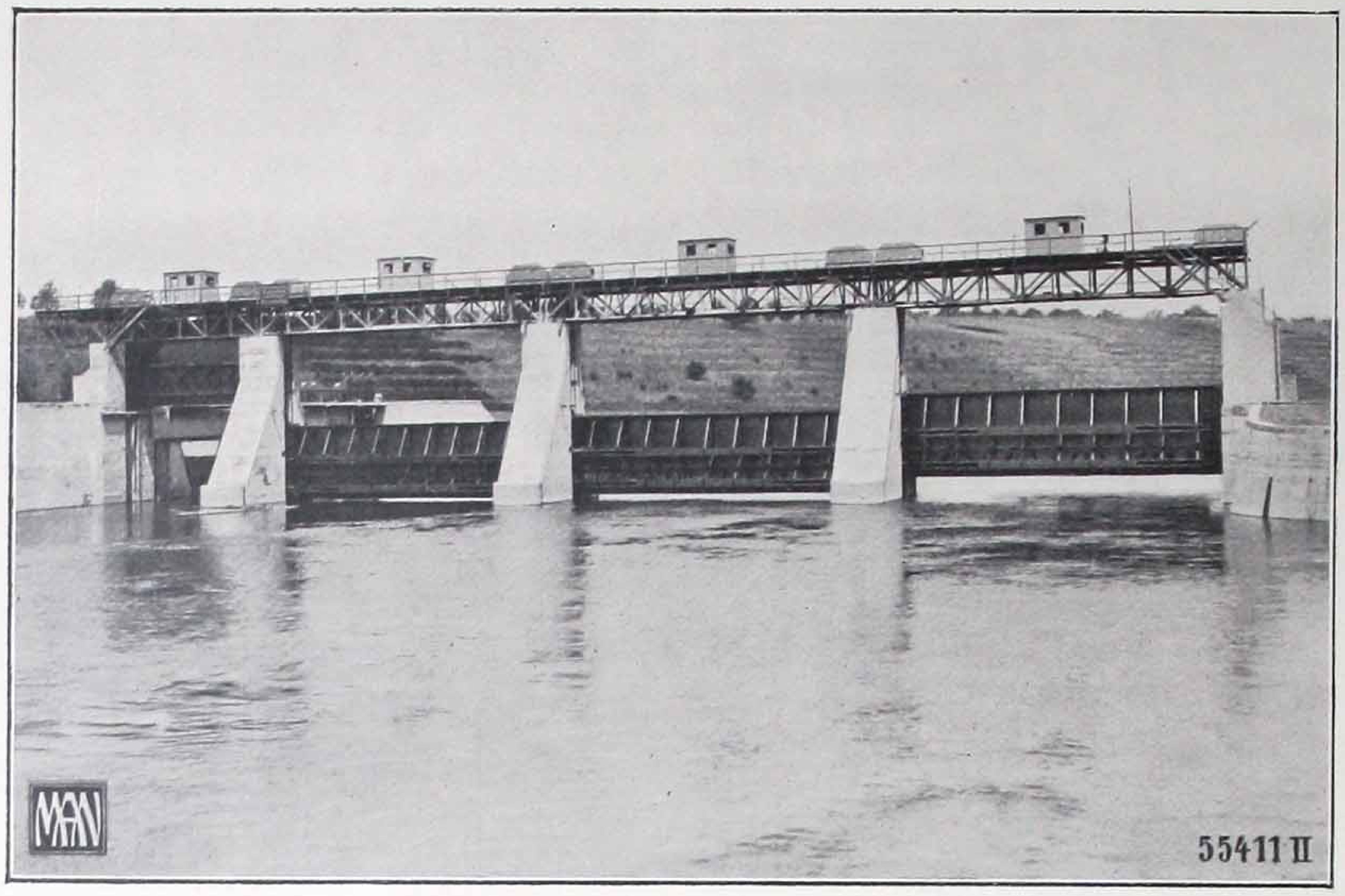


Fig. 22.
Weir in the Neckar river near Beihingen, power station at Altwurttemberg. 3 stoney sluices, clear spans each 59 ft. (18,0 m), height 16 ft. 5 in. (5,0 m). 1 patent double sluice: clear span 32 ft. 10 in. (10 m), height 19 ft. 8 in. (6 m), also damming beams.

The M.A.N. Double Sluice

possesses advantages similar to the submersion roller type. Lowering the upper sluice enables the water level to be regulated within fine limits and trash and ice released, without interference with the working of the power station supply. In order to minimise the loading and suction effects of the water, a very narrow sealing strip is fitted between upper and lower sluices so that the boards of the two sluice gates lie close together. – The sill packing consists of oak beams and the side packing of plates carrying oak beams fitted to the sluices, which pack against the iron armouring of the piers.

The packing of the horizontal joint between the upper and lower sluices is effected by a plate attached to the lower sluice in such a manner that it can freely follow any deflections. The same track suffices for both upper and lower sluices and thus only one recess, of rectangular section, is necessary in each pier. In consequence, the piers need not be so strongly constructed.

The upper and lower parts of the sluices may be operated by either separate gear or a common winch. With the latter arrangement, the winch gear is directly connected to the upper sluice only. When the top sluice is lowered below the normal damming height and until it is raised again to that level, the lower sluice is not affected. Only on further raising the upper sluice is the lower sluice brought up also. The upper and lower sluice gates are carried on roller carriages, designed according to hydrostatic calculations, as in the case of the single sluices. The amount by which the upper gate can be lowered is rouhgly a quarter of the total height of the sluice.

The M. A. N. double sluiccs have been greatly extended all over the world; up to date seventeen plants with together forty four openings have been carried out.

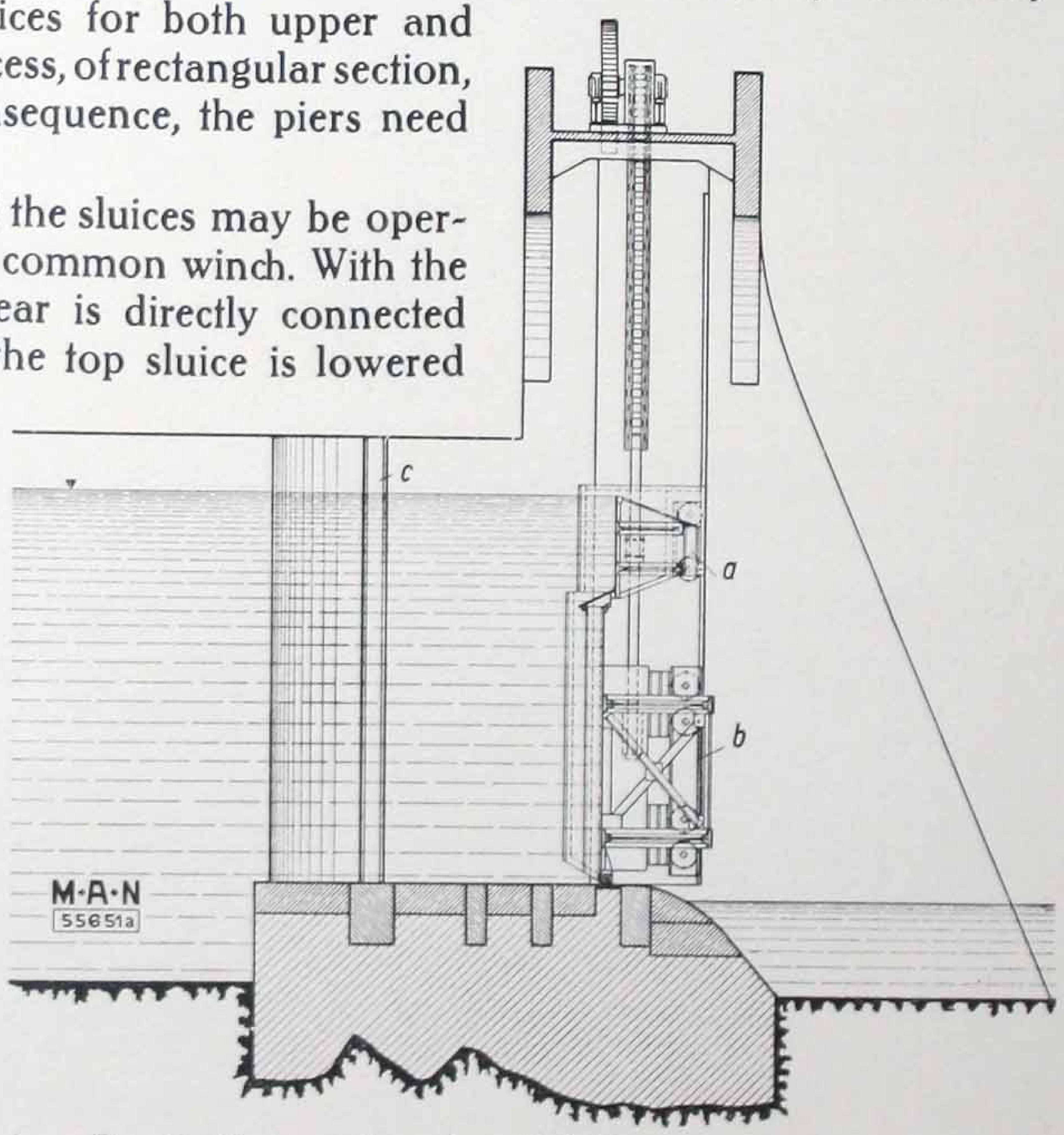


Fig. 23. Cross section of an M. A. N. patent double sluice.
a = upper sluice,
b = lower sluice,
c = recess for dam beams.

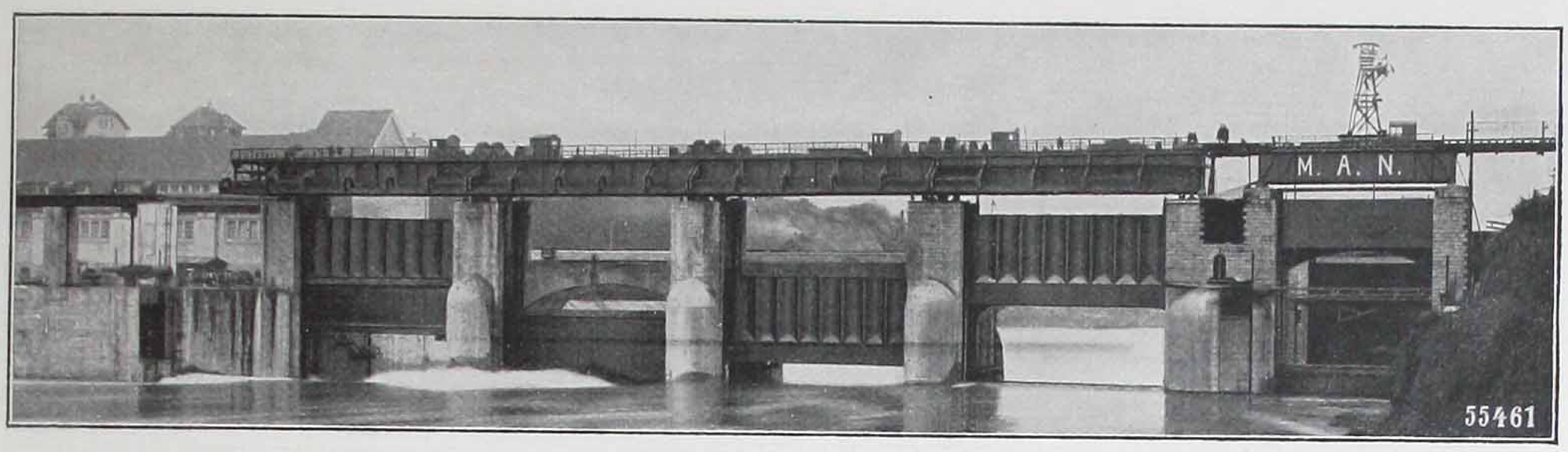


Fig. 24. Weir in the Rhine river near Laufenburg (Switzerland). 6 double sluices of a clear span up to 57 ft. (17.3 m) and 49 ft. 3 in. (15 m) damming height.

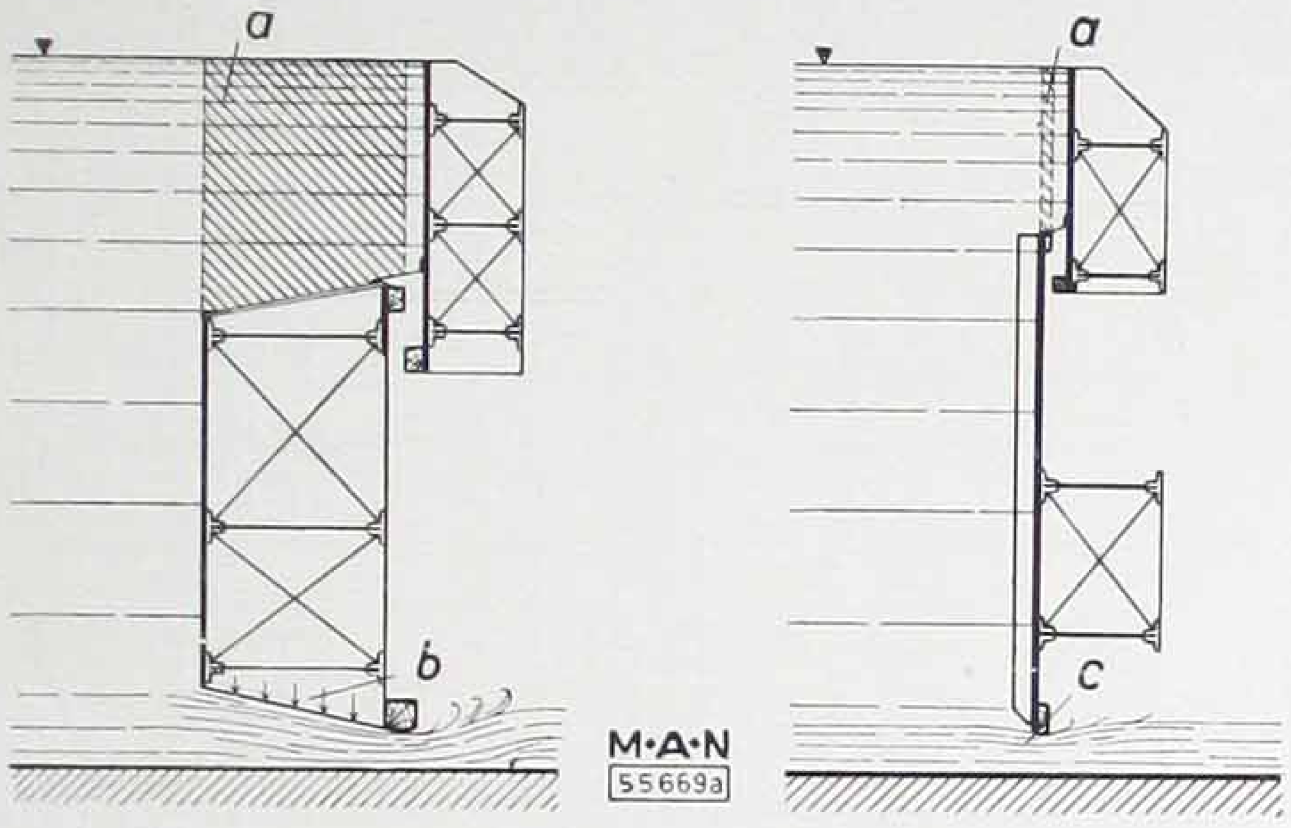


Fig. 25. Waterload and suction effect of a normal and of an M. A. N. patent double sluice.

a = loading effect
b = suction effect
c = suction effect = 0

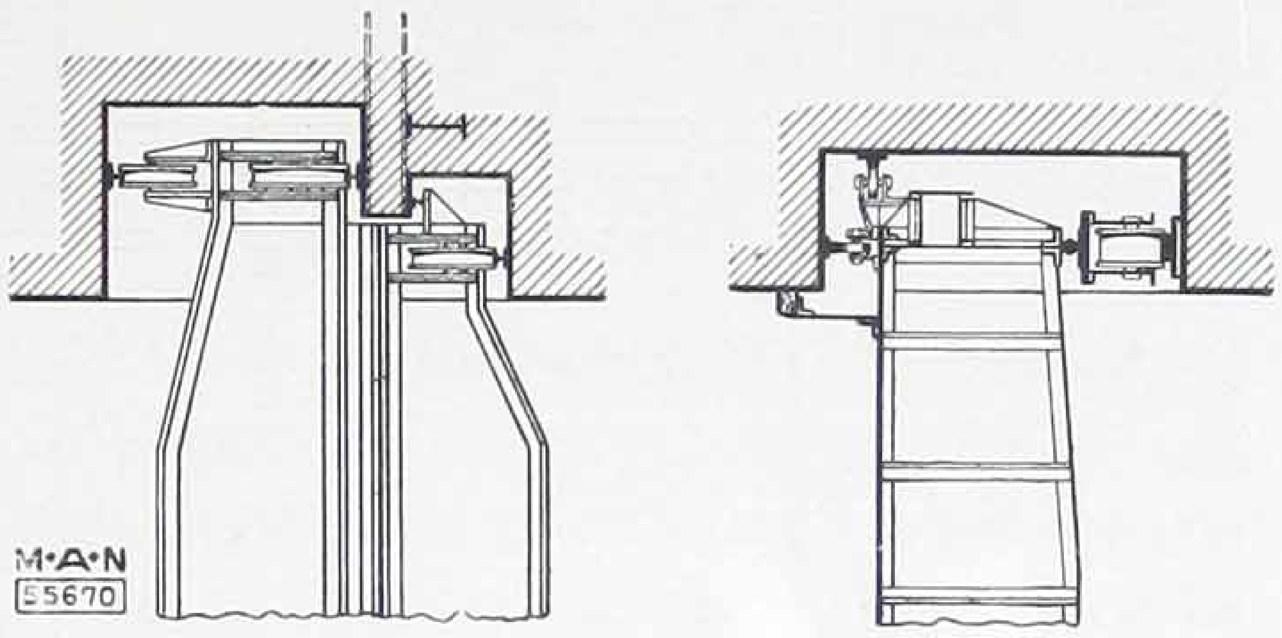


Fig. 26. Recess for normal and for M. A. N. patent double sluice.

Fig. 27. Weir in the Mur river near Pernegg (Austria). 3 M. A. N. double sluices each of 49 ft. 3 in. (15 m) clear span and 38 ft. (11.6 m) damming height with the necessary damming beams.

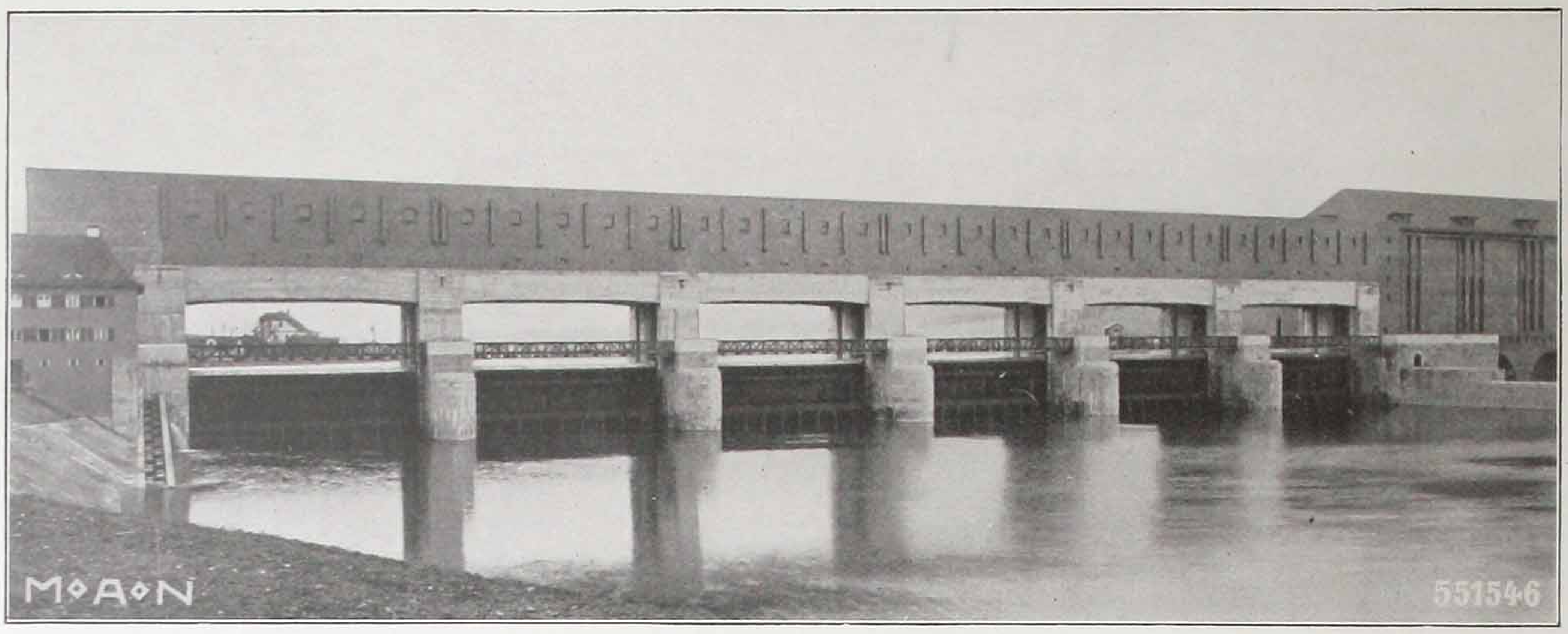


Fig. 28. Weir in the Danube river near Passau (Kachlet power station, Bavaria)
6 M. A. N. patent double sluices each of 82 ft. (25 m) clear span and 38 ft. 9 in. (11,8 m) damming height.
6 damming beams each of 82 ft. (25 m) clear span and 6 ft. 7 in. (2 m) damming height.

M. A. N. Guillotine Sluice

has been developed to cope with sudden increases in the flow of water to be dealt with, when it may be necessary to lower the upper sluice by a considerable amount in order to release the excess of water without interrupting the working of the power station.

The back of the weir being designed according to best hydrostatic practice the load from the water overflow is very small. As with other roller sluices, the two sluice gates are carried on roller carriages, designed in accordance with hydrostatic calculations, there being but one track for the two sluices. The main advantage remains, however, the large amount by which the upper sluice can be lowered.

In the last few years, four contracts, involving four openings, have been executed.

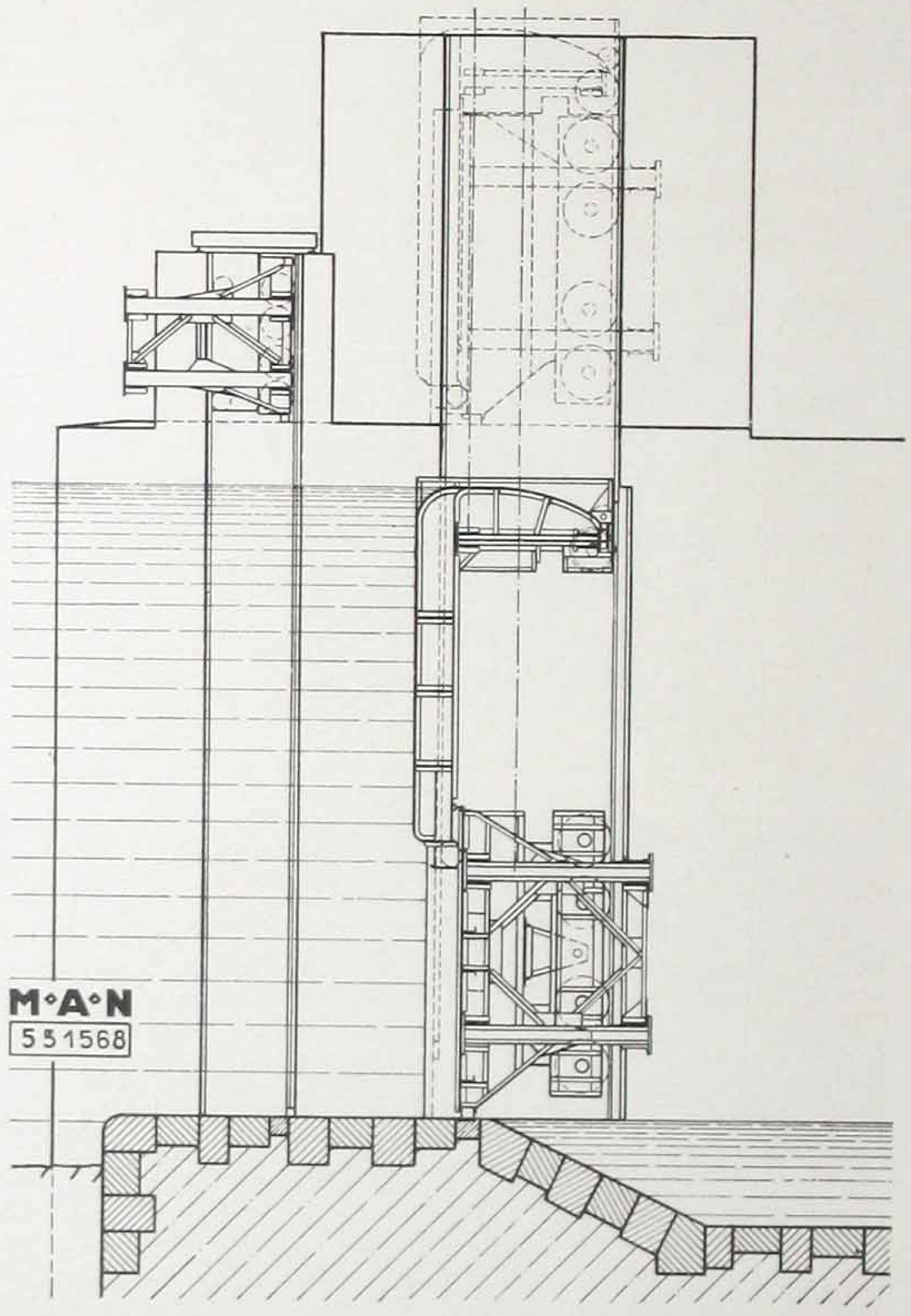


Fig. 29. Cross section of M. A. N. guillotine sluice with winding gear, damming beam closure and crane. The largest plant of this kind (to date) in the Rhine river near Ryburg-Schwörstadt (Baden).

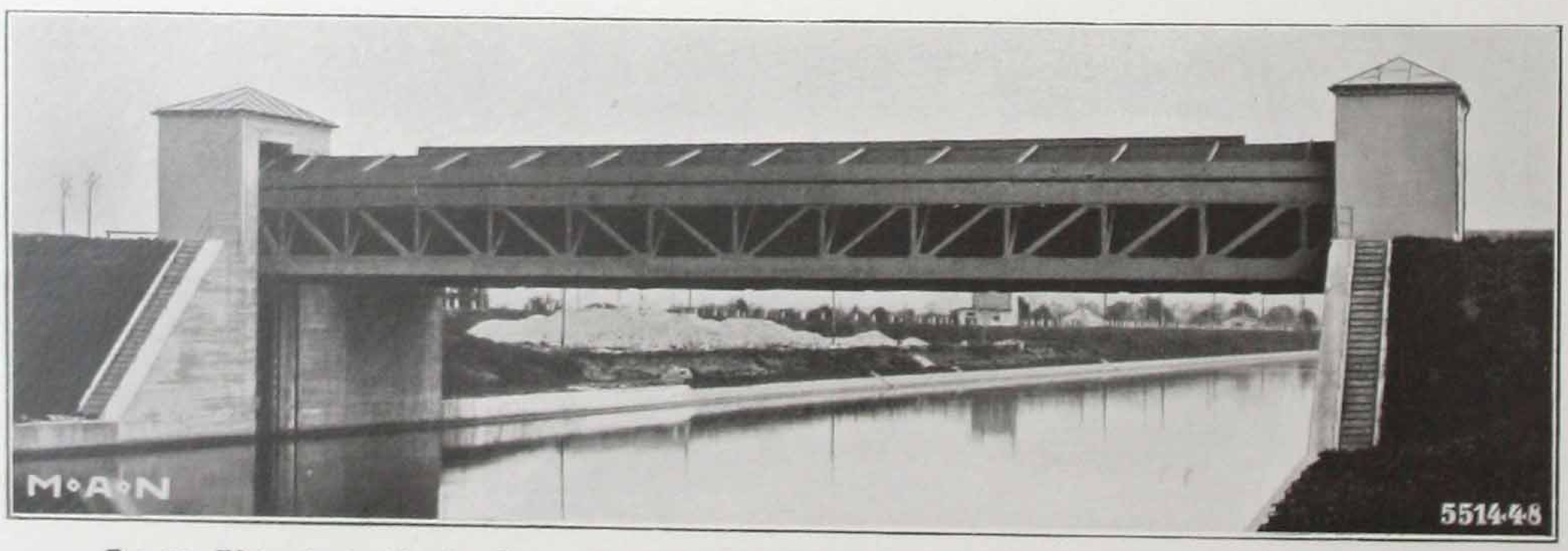


Fig. 30. Weir plant at Ladenburg (Baden). 1 M. A. N. double guillotine sluice as high water closure of the Neckar channel.

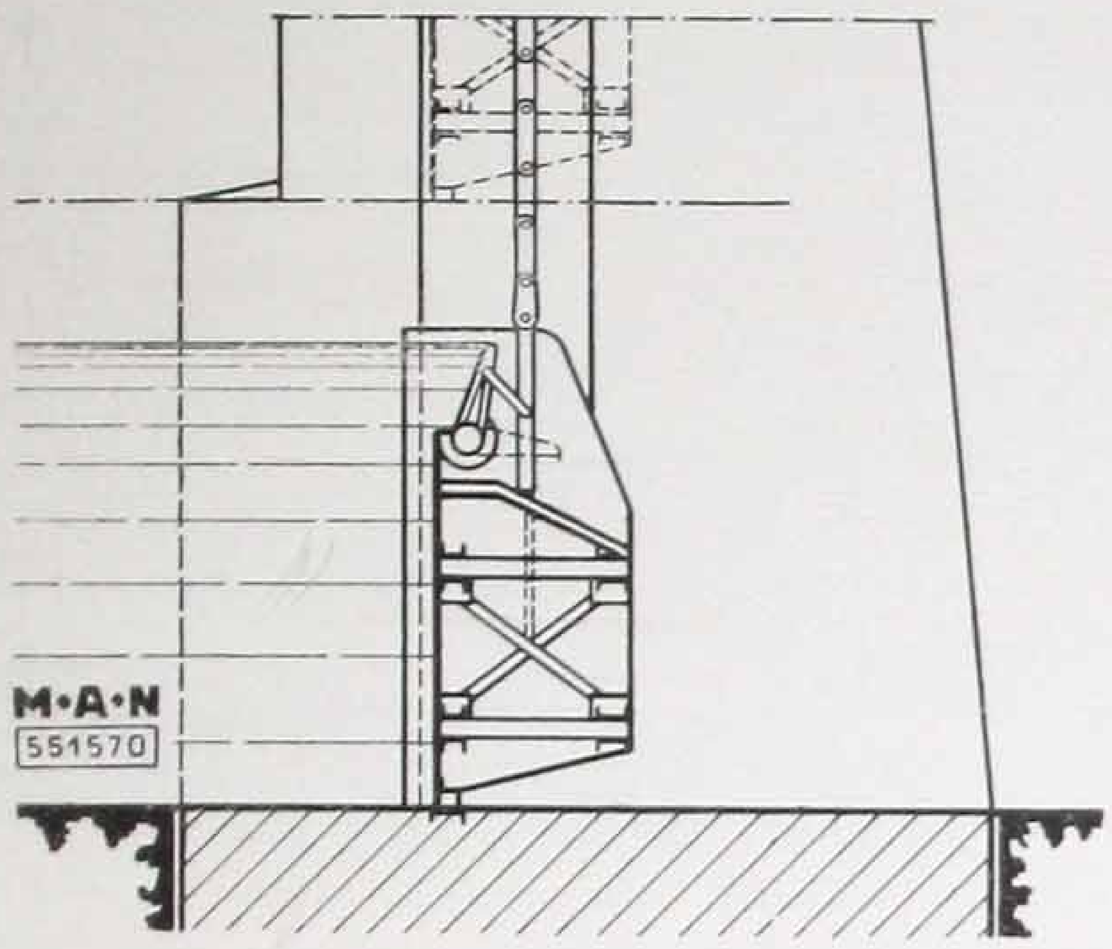


Fig. 31. Cross section of a sluice with flap.

Flap Sluices

have the same advantages as M.A.N. double and submersible weirs, namely gravel and trash of every description can be discharged over the weir with a minimum waste of water.

Flap sluices fitted on main sluices have been frequently designed, but rarely executed in practice until the introduction of the torsionless flap led to their more extensive adoption.

The flap is hinged on the upper portion of the sluice on a tube of sufficient strength to eliminate all possibility of torsion. The bending and turning forces on the flap are therefore only effective at the ends of the flap. Consequently driving gear is only necessary at the ends of the main sluice.

Flap sluices therefore enable the flap drives to be connected with the drive of the main sluices, so that the latter can be lifted and lowered with the flap in any position.

Since the introduction of this system, M.A.N. have already carried out 7 contracts with a total of 15 flap sluices.

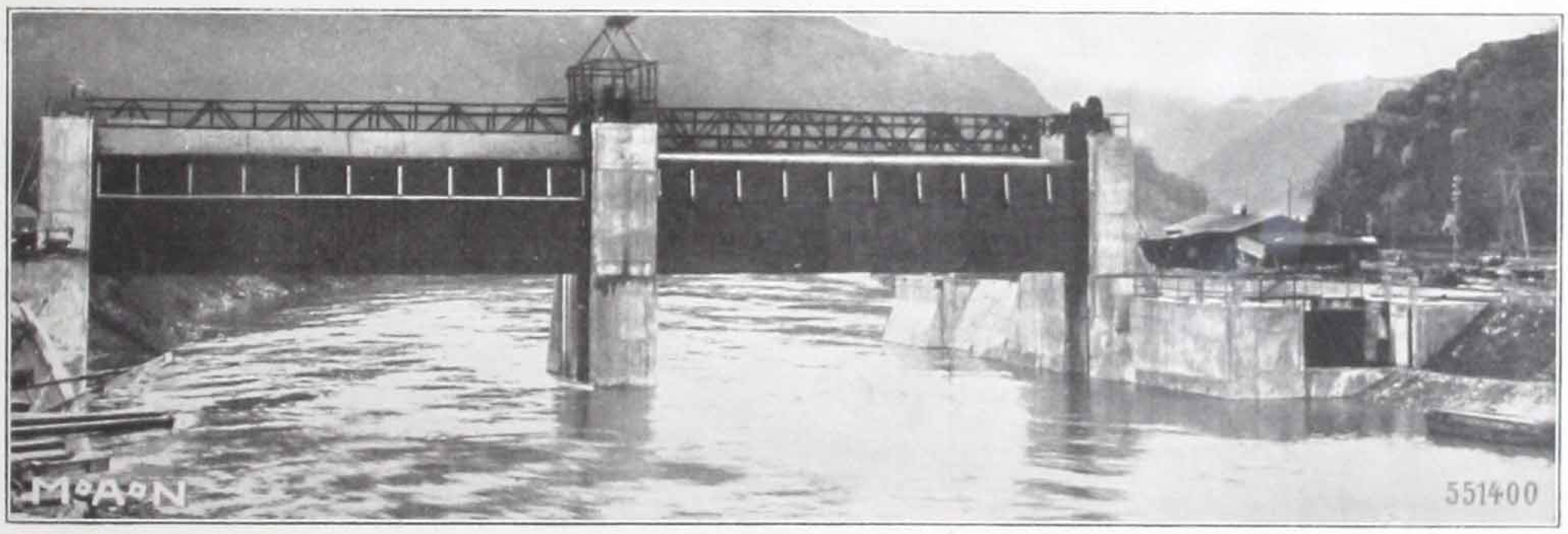


Fig. 32. Weir in the Lahn river near Cramberg (Hessen).
2 sluices with flaps each of 74 ft. (22,5 m) clear span and 21 ft. 6 in. (6,57 m) damming height. Submersion depth 3 ft. 3 in. (1 m).

Submersion Sluices.

They are suitable for low damming heights, where fine regulation is desired, and are arranged to submerge in a similar manner to the roller weirs. Regulation of the water is, of course, effected by overflow.

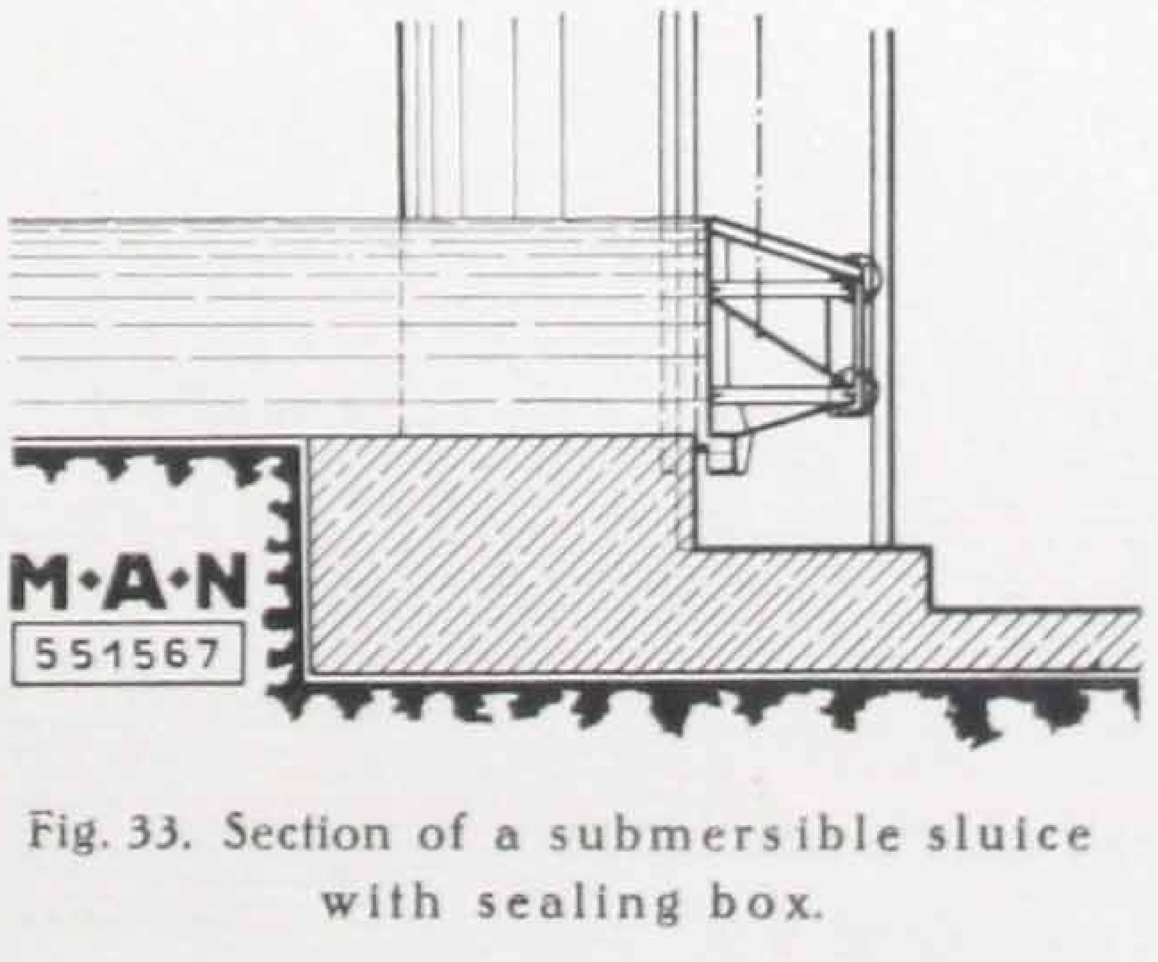


Fig. 33. Section of a submersible sluice with sealing box.

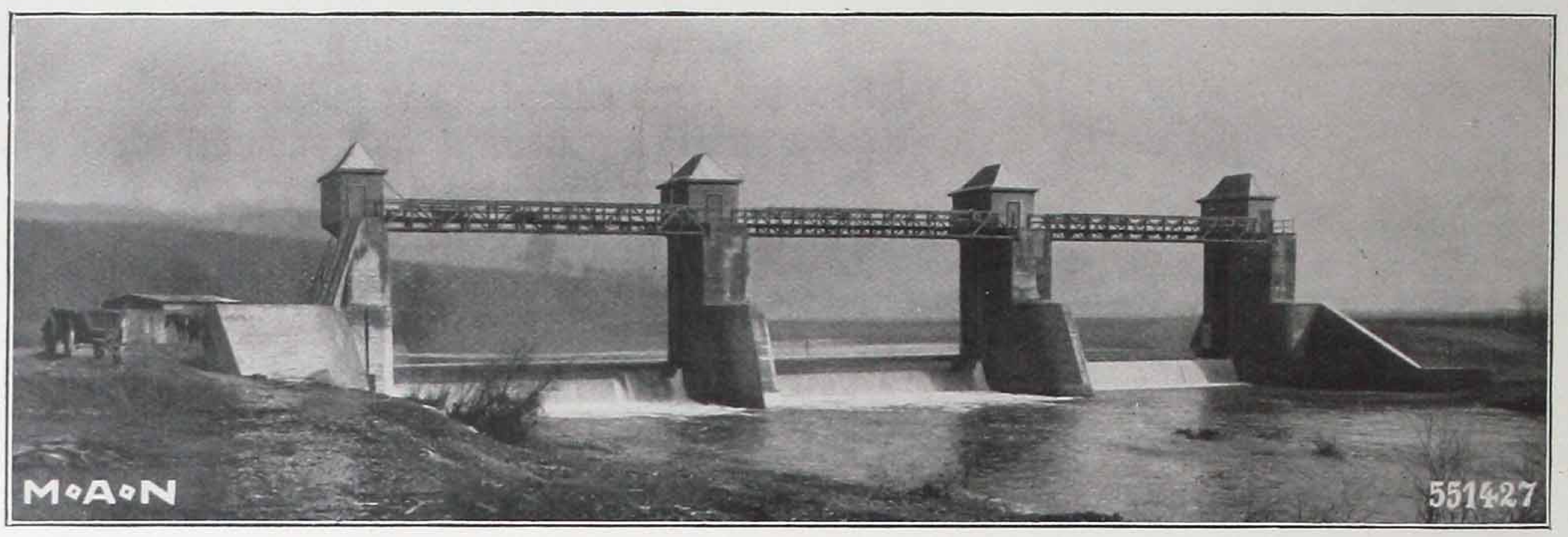


Fig. 34. Weir in the Ruhr river near Wickede (Ruhr district). 3 submersible sluices each of 69 ft. (21 m) clear span and 9 ft. 4 in. (2,85 m) damming height.

Other Weirs.

Bascule Weirs

are suitable as regulators for main dams. By reducing the damming level the weir becomes accessible without the use of auxiliary damming devices.

Another feature is that no structural parts will be above water level in cases where, for architectural reasons, this is desirable, as the bascule is driven on one or both ends and requires no further gangway or other superstructure.

As a main weir the bascule type can only be applied in those instances where a deepened weir sill can be arranged, below which the flap can be accommodated.

The bascule weir is designed as a torsionless cylinder on which the damming shield is rivetted and driven on one or both ends. Amongst the advantages are the hydraulically favourable cross section for discharging the water, the simple seal at the cylinder, the possibility of application to large spans, and the simple construction of the steel bearings which allow of easy dismantling and which are carried on bronze plates. In order to be able to carry out the necessaryi reparing or painting work, auxiliary closing devices become necessary above and below the water level.

The Bascule weir has been widely adopted and 29 such plants have been put into operation by M. A. N.

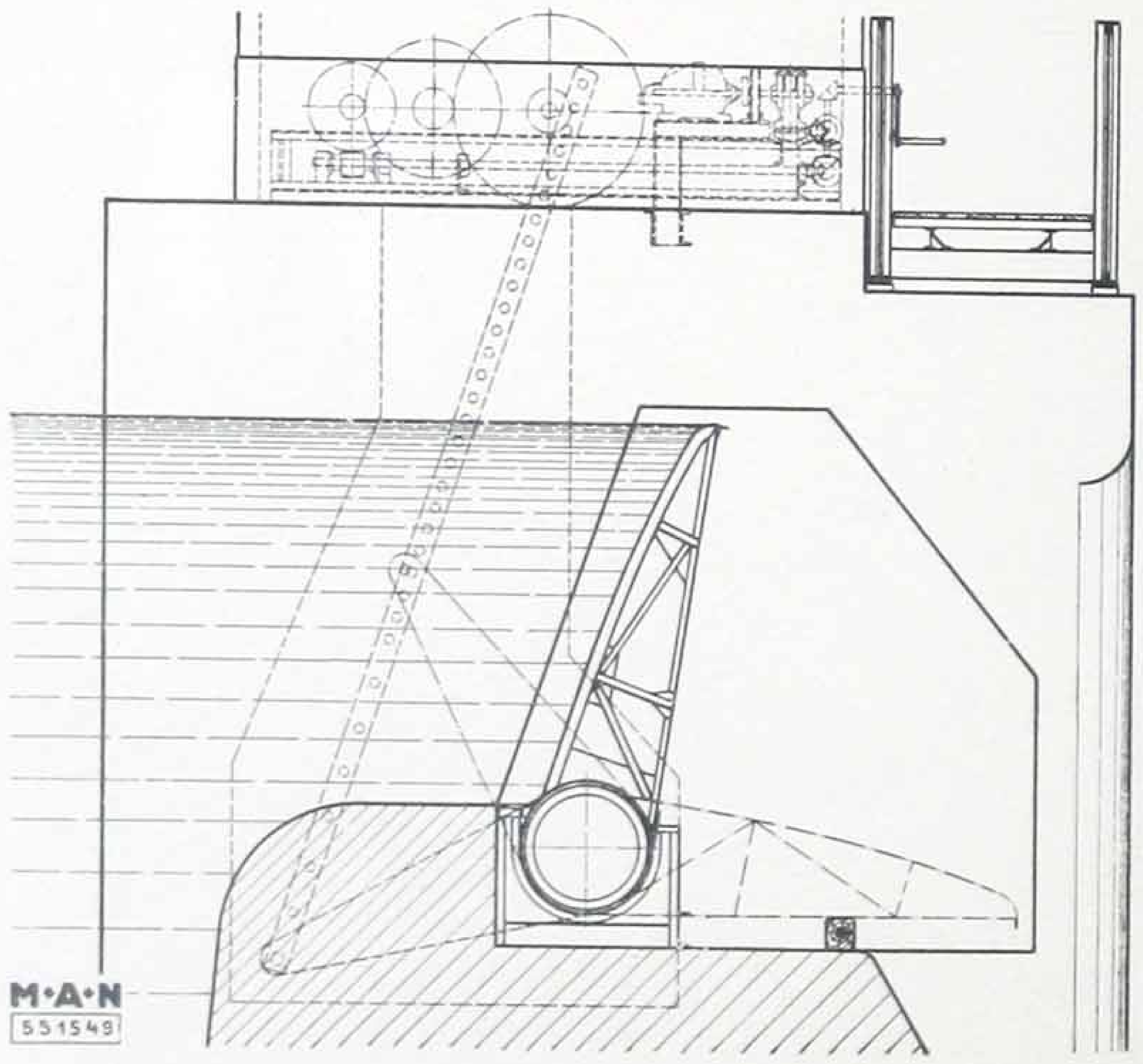


Fig. 35. Cross section of a Bascule weir.

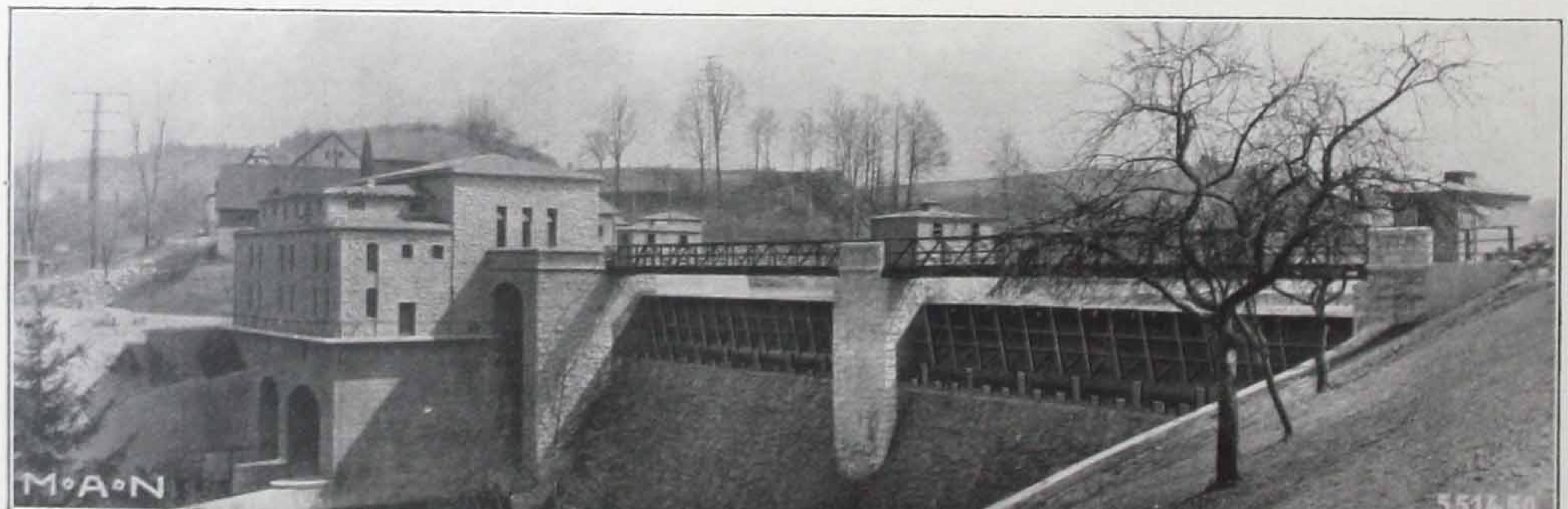


Fig. 36. Bascule weir in the Bober river near Boberullersdorf (Prussia). 2 bascules each of 78 ft. 10 in. (24 m) clear span and 10 ft. 6 in. (3,2 m) damming height.

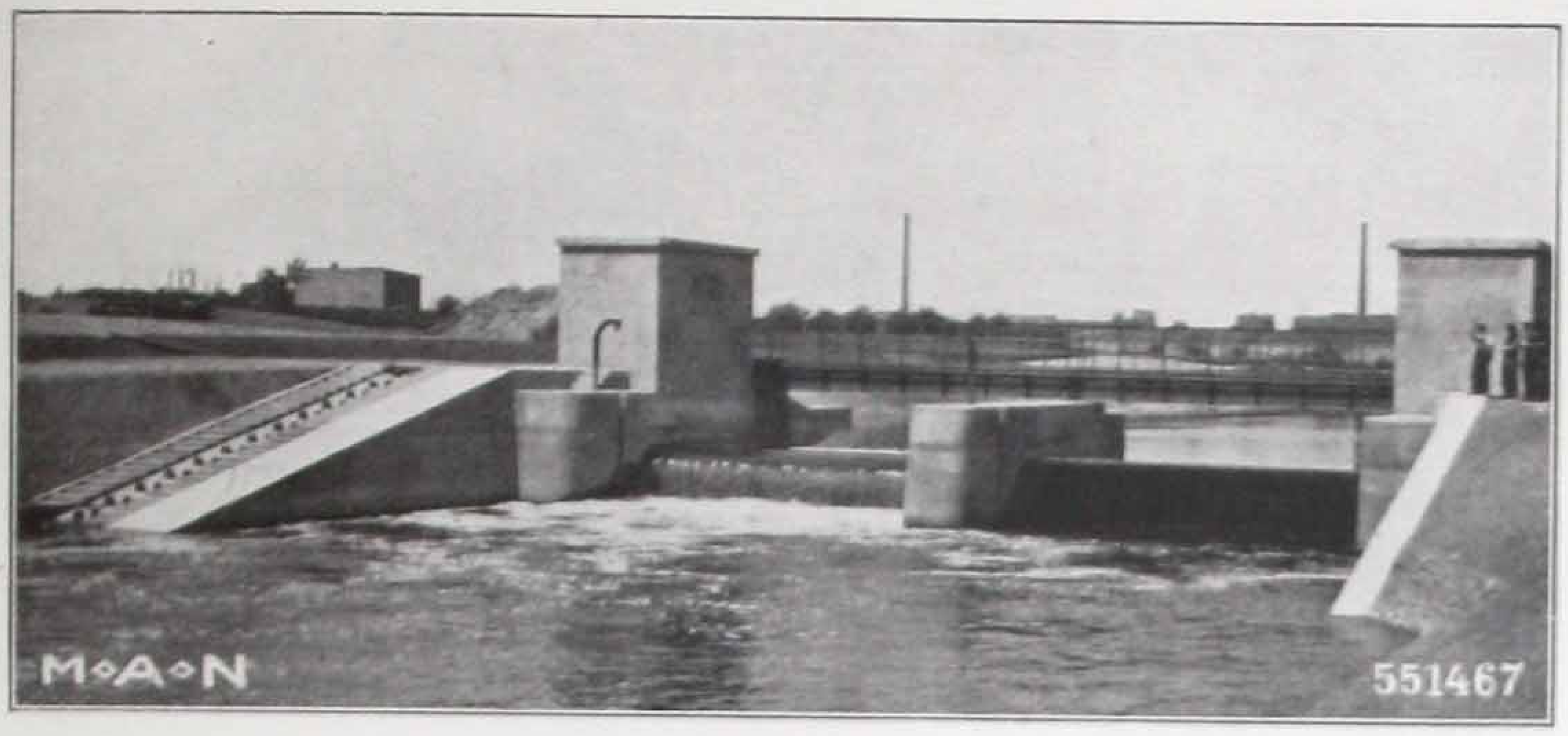


Fig. 37.
Weir plant in the Nidda river near Frankfurt on Main.
4 weirs with 2 bascules each of 29 ft. 7 in. (9 m) clear span and 8 ft. 11 in. (2,7 m) to 11 ft. 6 in. (3.5 m) damming height.

Sector Weirs.

As the name implies, the movable body of the sector weir is, in cross-section, a sector of a circle. This is mounted on the back of the fixed weir by a continuous shaft round which it pivots when being submersed into the fixed base. The sector is held at any particular height simply by the water pressure in the interior acting on its back shield, each position of the movable sector corresponding to a definitive pressure in the dam chamber. Consequently, by alteration of this water pressure, the weir can be moved without recourse to either a motor or winch gear.

By lowering the weir, ice and drift of all kinds, including even trunks of trees, can be discharged without great loss of water – the straight back of the weir being particularly suited to this purpose.

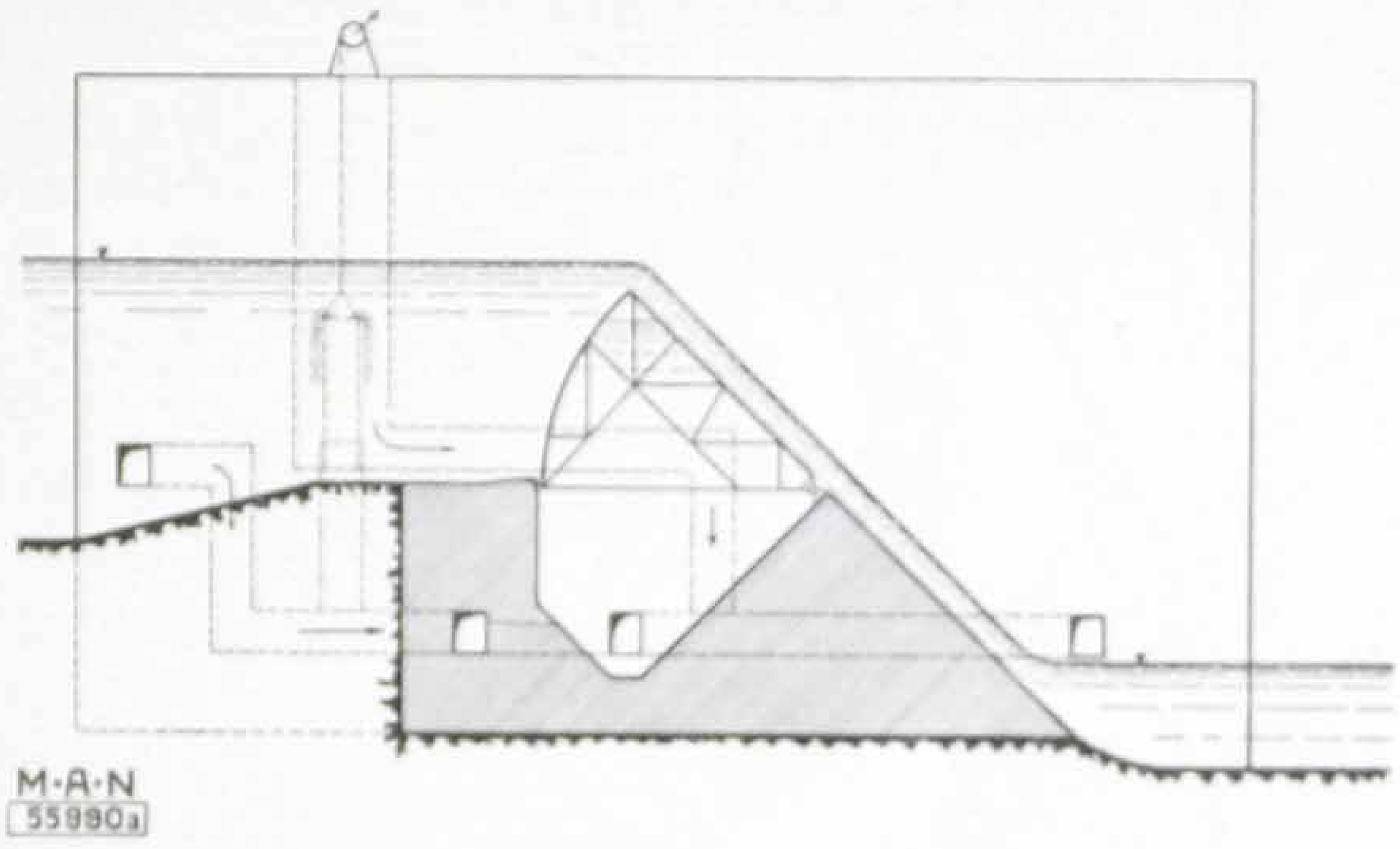


Fig. 38. Schematic cross section through a sector weir.

Sector weirs can also be provided with automatic fine regulation by means of a pipe sluice, consisting of two pipes engaging in one another after the manner of a telescope.

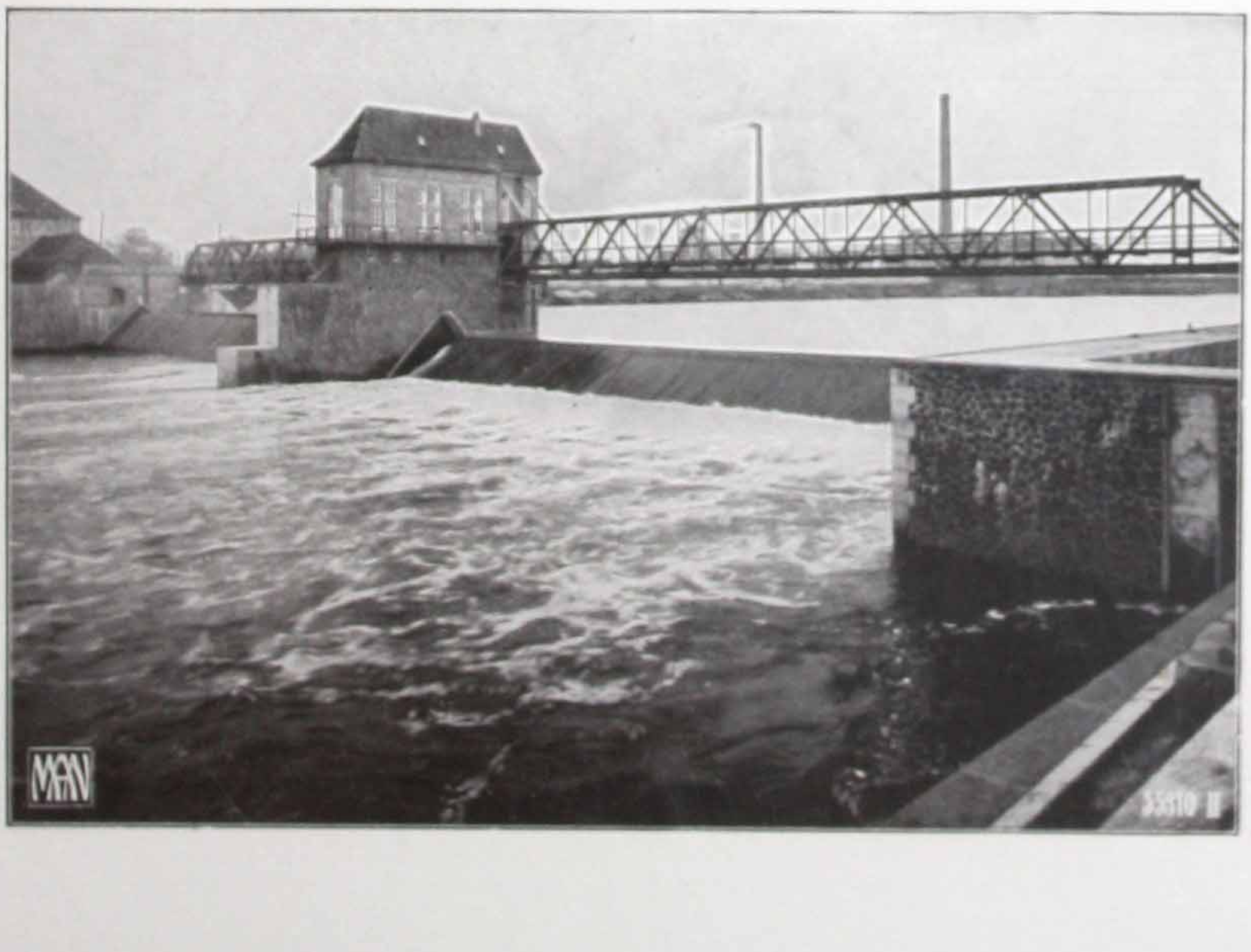


Fig. 39.
Weir in the Weser river near Bremen.
First sector weir built in Germany in 1911.
2 sectors each of 177 ft. (54 m) clear span and 14 ft. 9 in. (4,5 m) damming height.

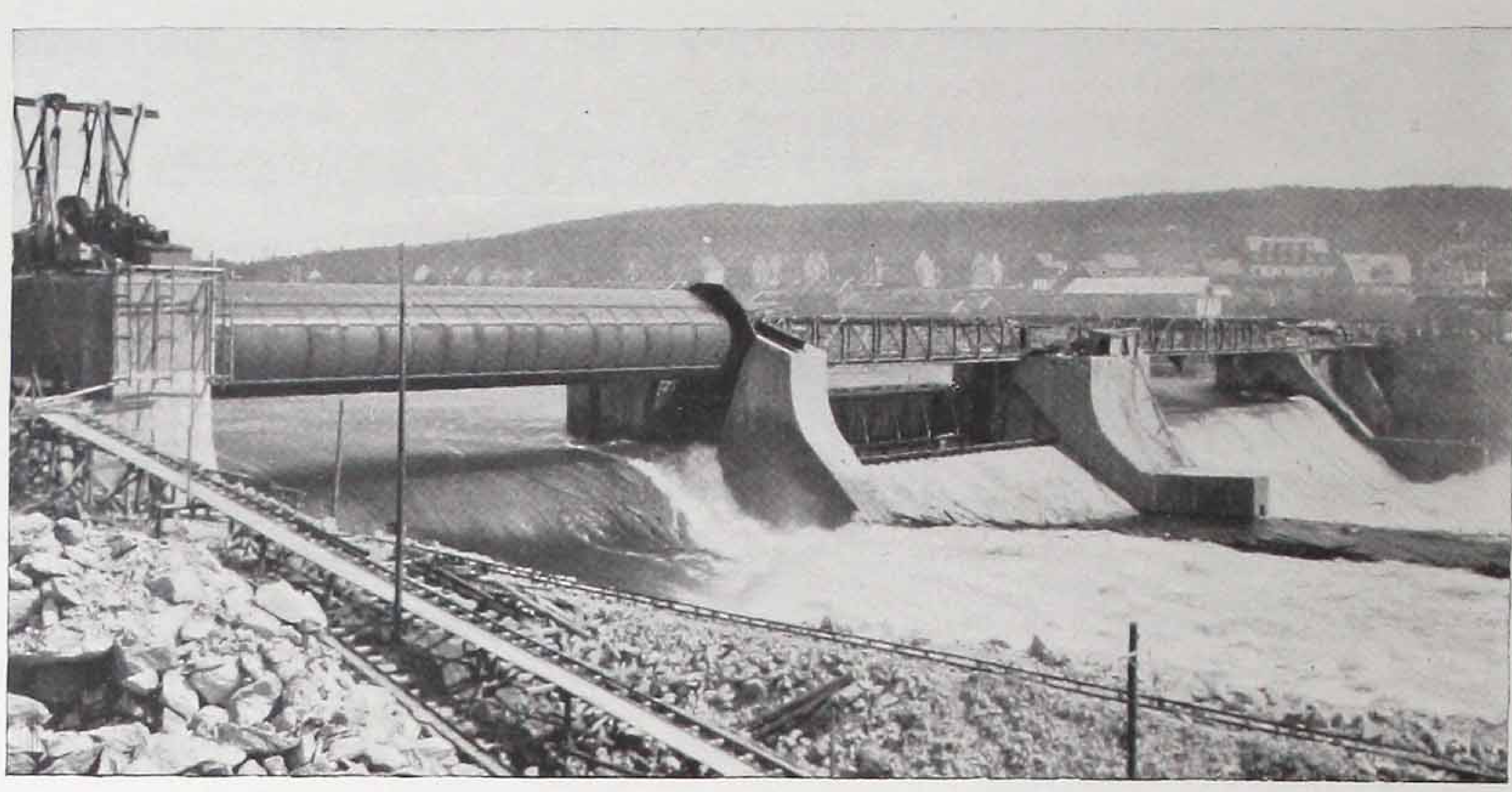


Fig. 40.
Weir plant in the Glommen river near Raanaasfoss (Norway).
2 sectors each of 164 ft. (50 m) clear span and 13 ft. 2 in. (4,0 m) damming height.
1 roller of 148 ft. (45 m) clear span and 21 ft. 4 in. (6,5 m) damming height.

Segment Weirs

are suitable for closing pressure culverts, as the influence of the water pressure upon the raising of the gate is practically nil. As main weir closures opened by raising they are only adapted to small or medium sized constructions. They can also be designed as submersible weirs pivoted on a continous shaft. Segmental weirs are cylindrically curved shutters which turn about their horizontal axis and are operated by means of chains and winch gear.

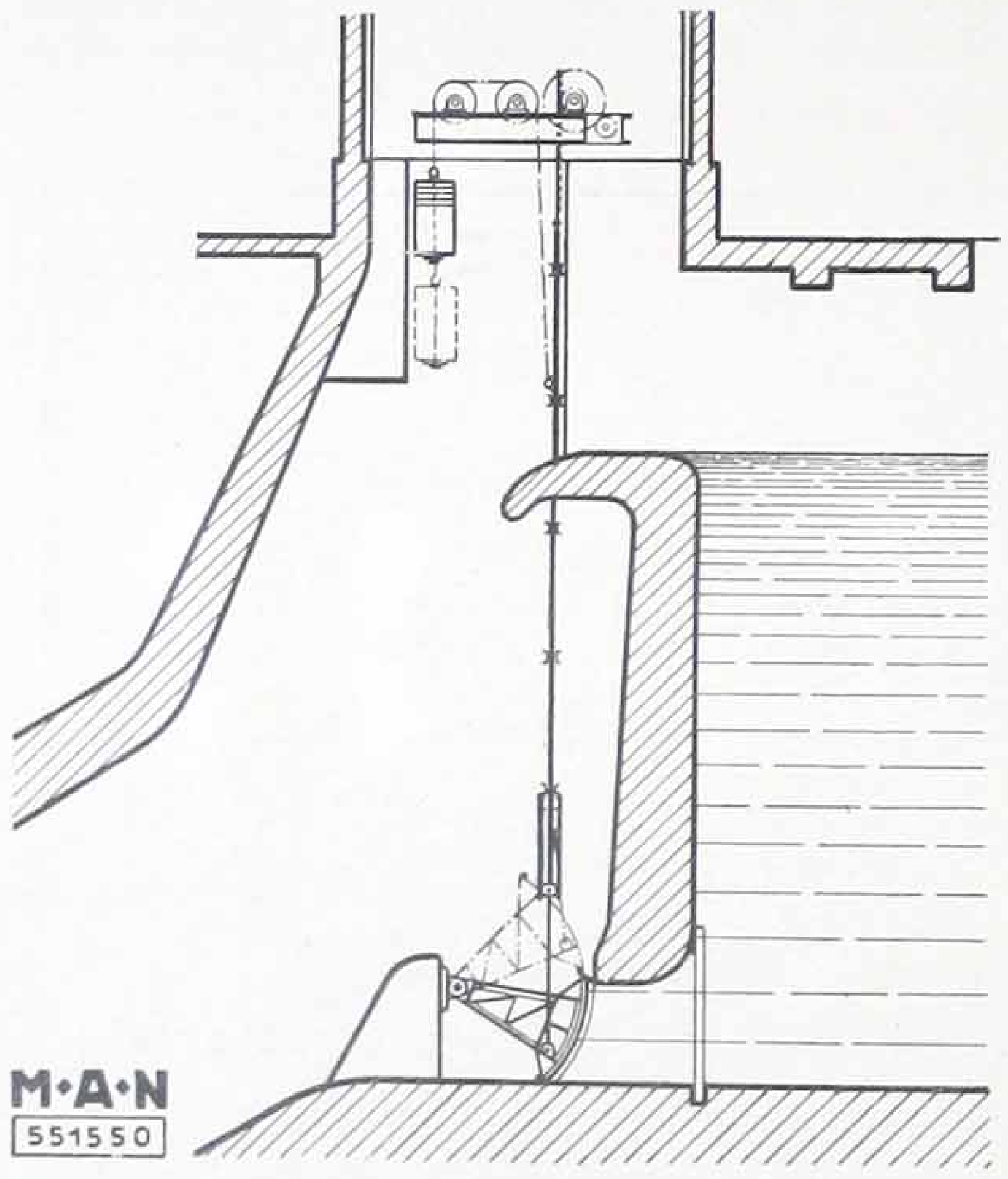


Fig. 41. Cross section of a tunnel closing sluice.

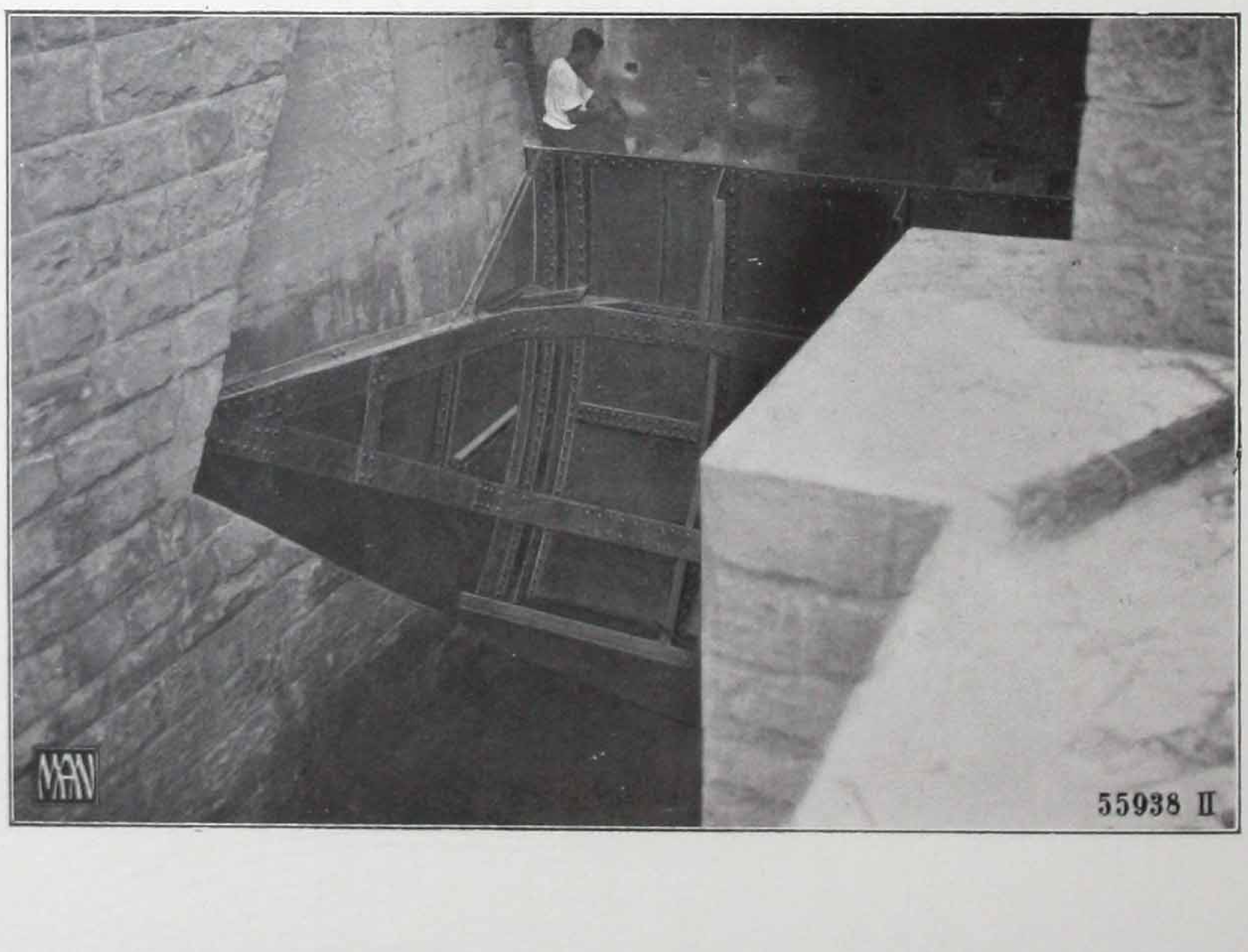


Fig. 42.
Segment weir on the Itter near Eberbach Itter Power Station (Baden).
Clear span 9 ft. 10 in. (3,0 m), closing body height 9 ft. 2 in. (2,8 m).

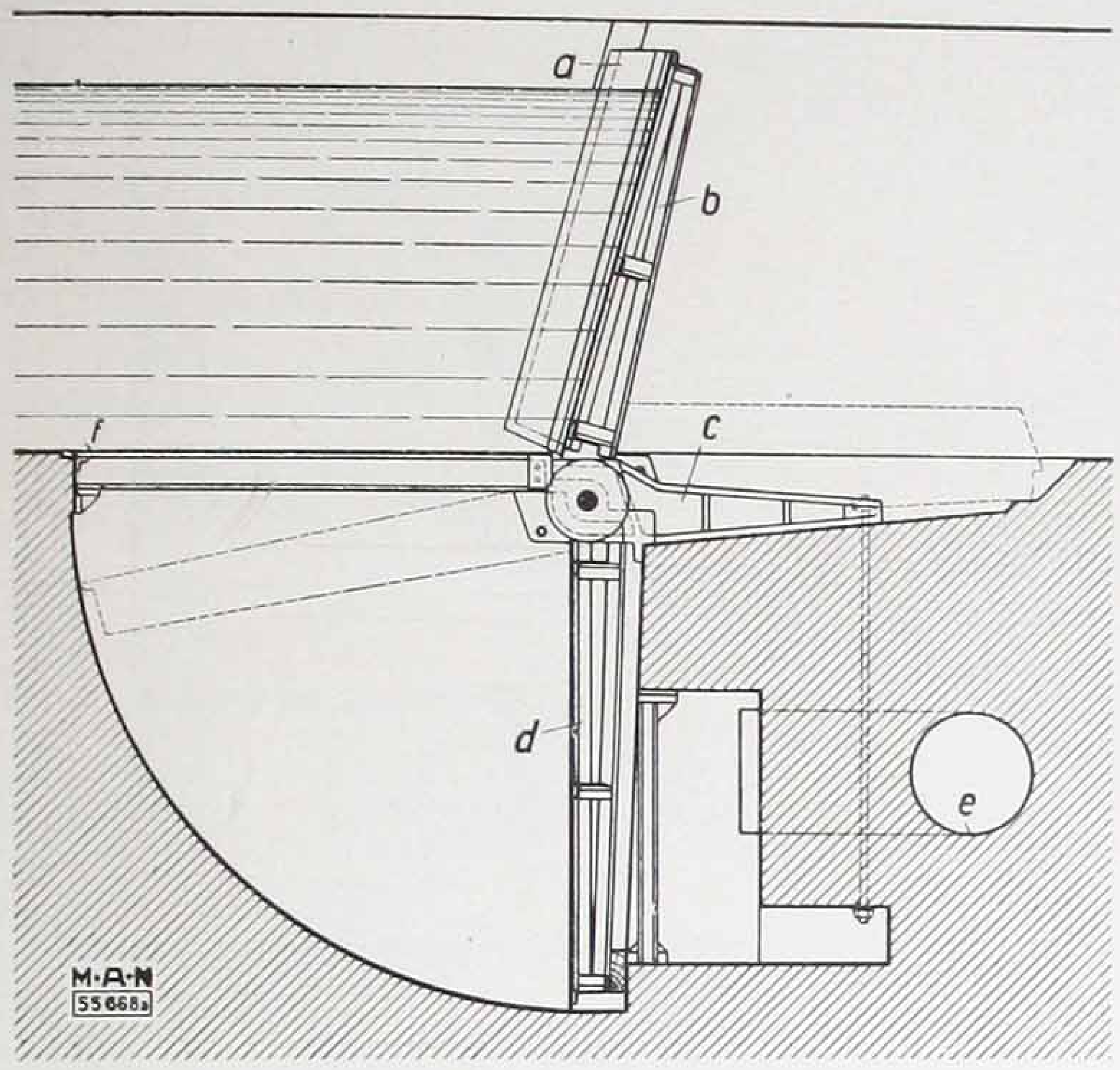


Fig. 43. A drum weir scheme.
a = side packing, b = damming flap, c = bearing,
d = regulating flap, e = water piping. f = packing plate.

Drum Weirs

are employed for closing rafting canals and weir openings of limited height. Regulation is effected hydraulically and, by means of a special device, can readily be made automatic. The movable wicket is a framework covered by steel plates free to revolve in a number of cast iron bearings about its middle axis. The upper part, that is the weir proper, acts as a shutter, while the lower portion serves to raise or lower the whole wicket. The weir is manoeuvred by the admission or running off of water to and from the up-stream and down-stream sides of the counter-wicket, through culverts in the piers and in the body of the dam.

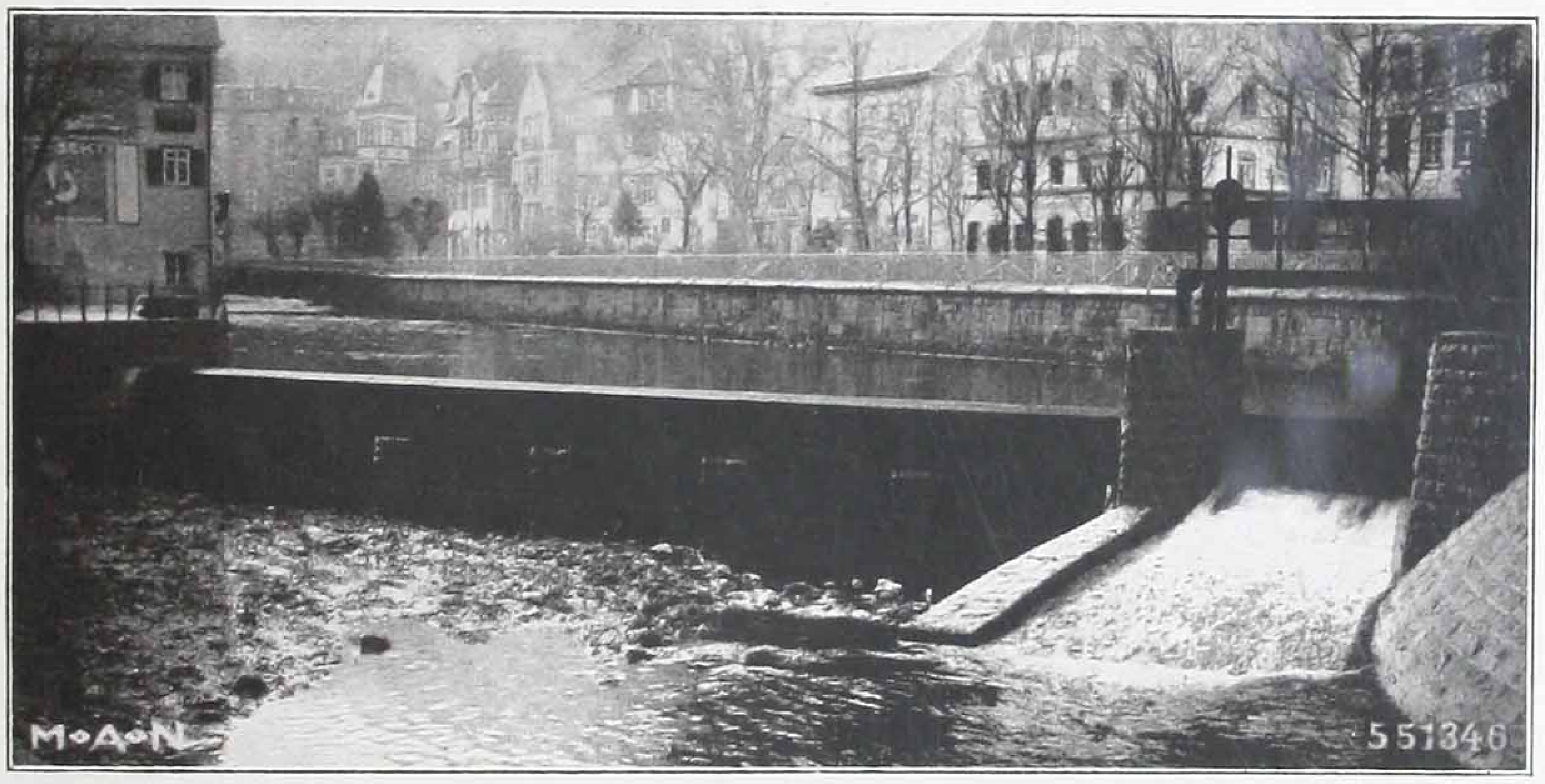


Fig. 44. Drum weir in the Enz river near Wildbad (Wurttemberg).
1 drum 78 ft. 10 in. (24 m) clear span and 3 ft. 3 in. (1 m) damming height.

Emergency Dams.

These are put into service when repair work is to be executed. For low damming heights the simplest type is that which employs shells provided with grooves which are fitted against plates embedded in the concrete. The dam boards are then dropped between the shells. In the case of roller weirs an emergency closure is in general unnecessary, as, on account of the great reliability and sturdy construction of the roller, there is little likelihood of any necessity for repair work while water is actually being retained: if required, however, it is effected in the form of an emergency dam in the head water (Fig. 5).

The emergency dams most frequently employed are beam dams and needle dams.

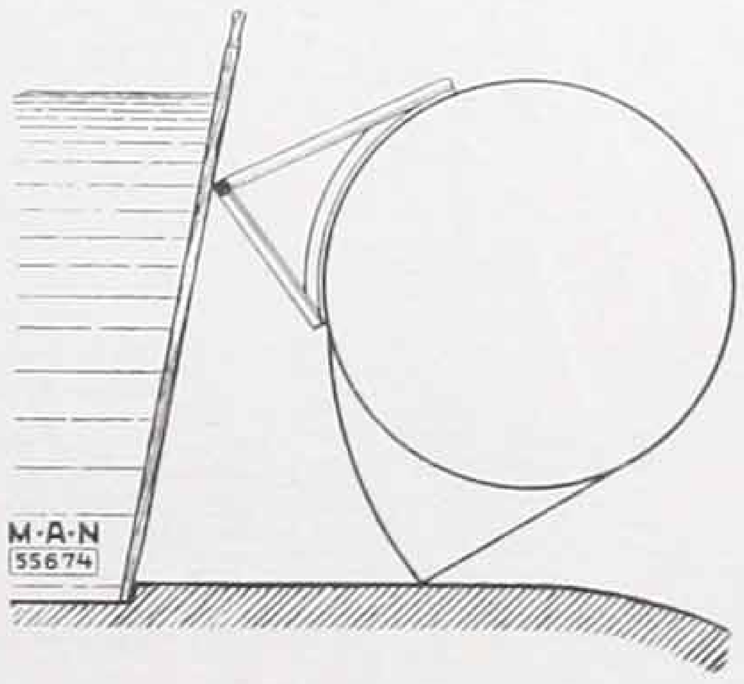


Fig. 45. Cross section
of a roller weir with needle
weir as emergency closure.

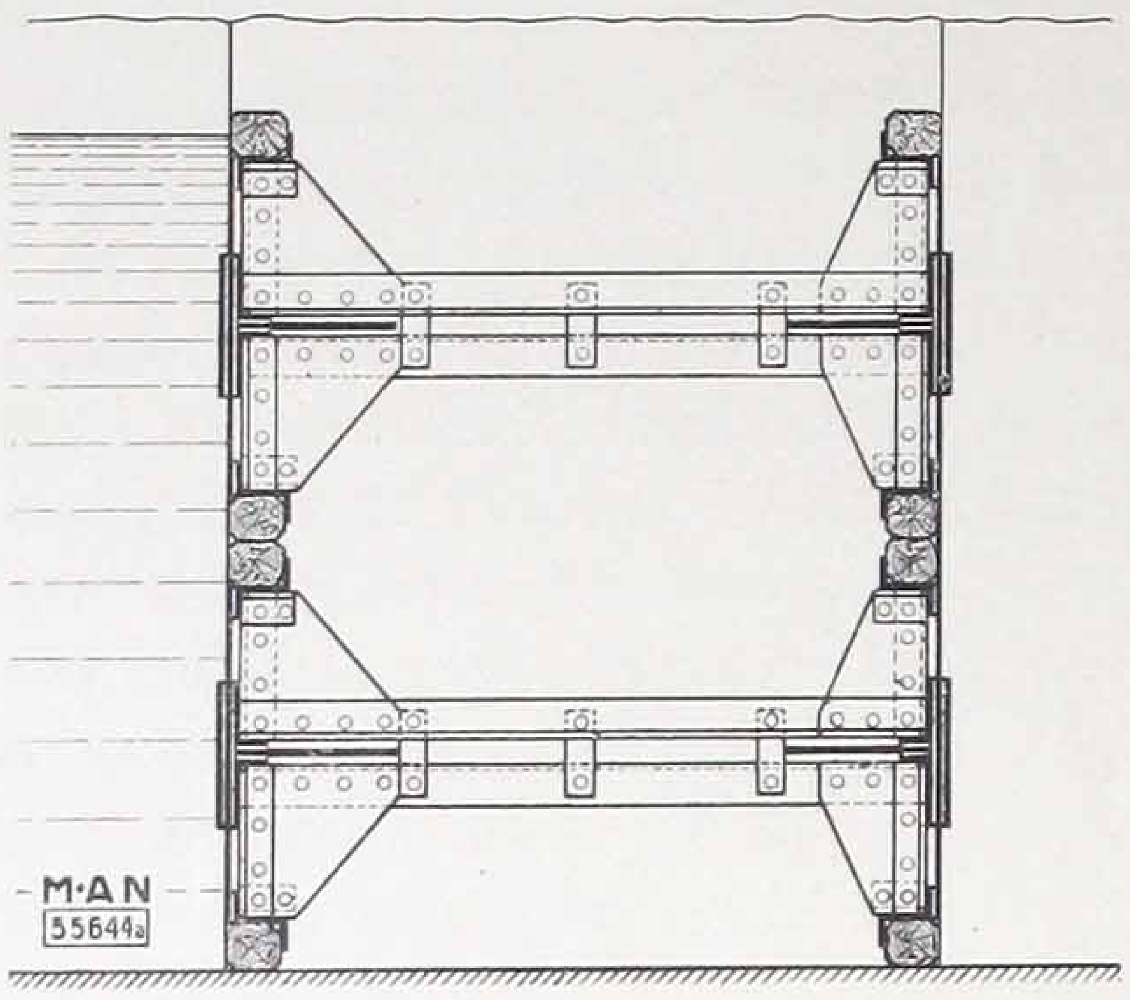


Fig. 46.
Damming beams of plate construction.

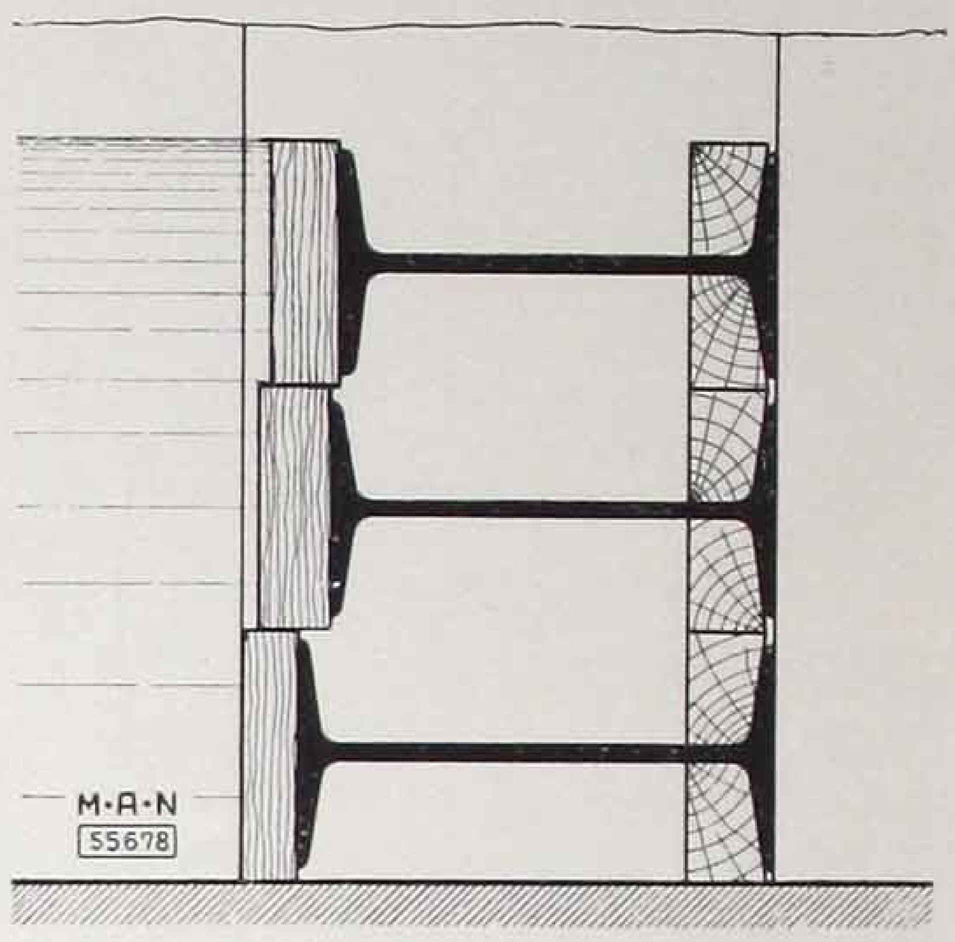


Fig. 47.
Damming beams of I-shaped girders.

Beam Dams

serve for the closure of the entire damming width, but can only be used efficiently where there are a number of equal-sized openings. The cross-section of the dam beams may either diminish towards the top of the dam or be the same throughout. The beams are stacked on a spezial storage ground or, more conveniently and cheaply, upon the pier-heads of each opening.

The handling and placing in position of the dam beams is effected by a special crane. In order that the beams may be put in under water without the aid of divers and brought up again when desired, a ton beam is employed. To facilitate the placing of the beams in the running water they are provided with rollers.

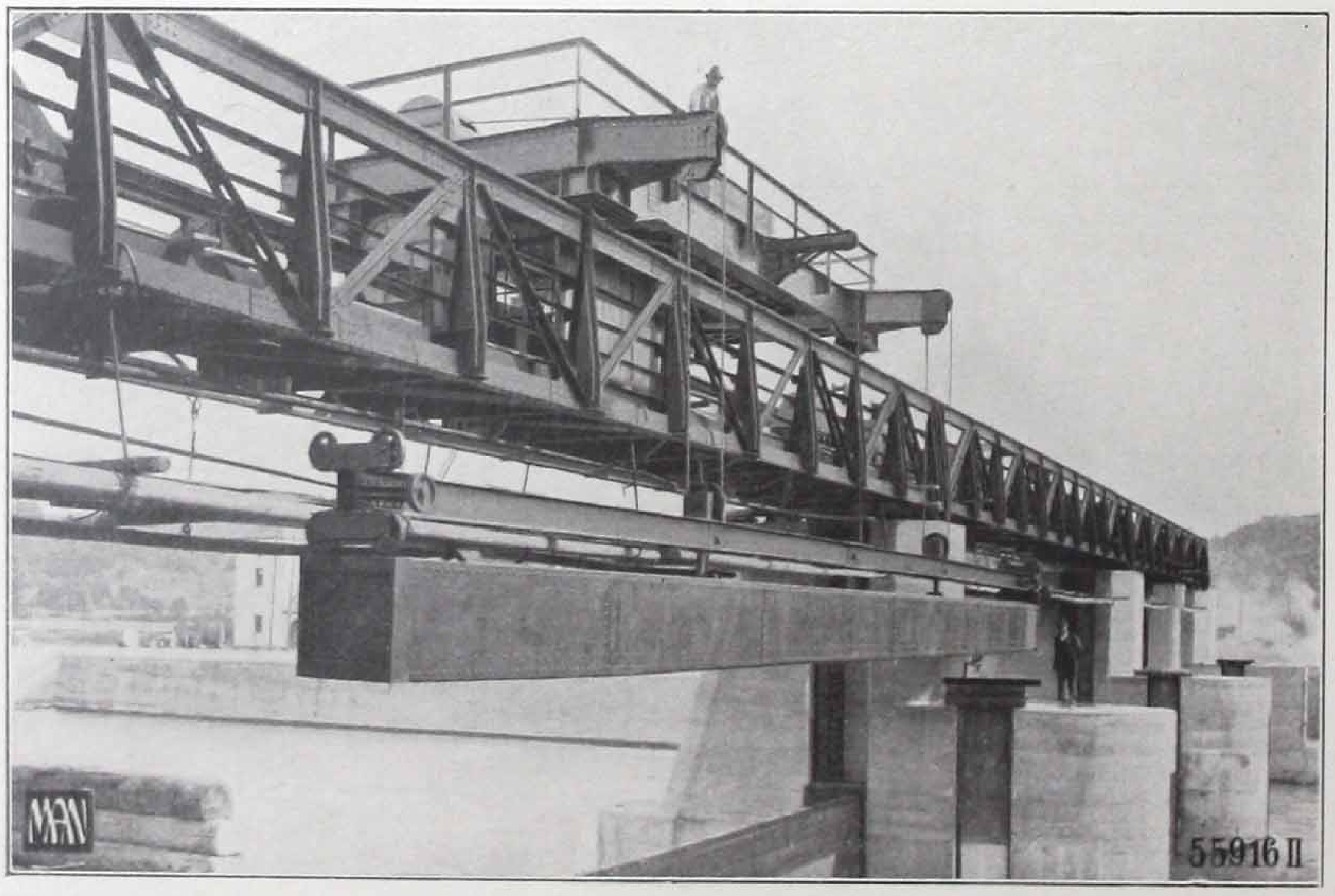


Fig. 48. Weir in the Alz river near Hirten (Alzwerke Ltd., Bavaria).
Damming beams being placed in position by means of beams fitted with tongs and suspended on a damming beam crane.

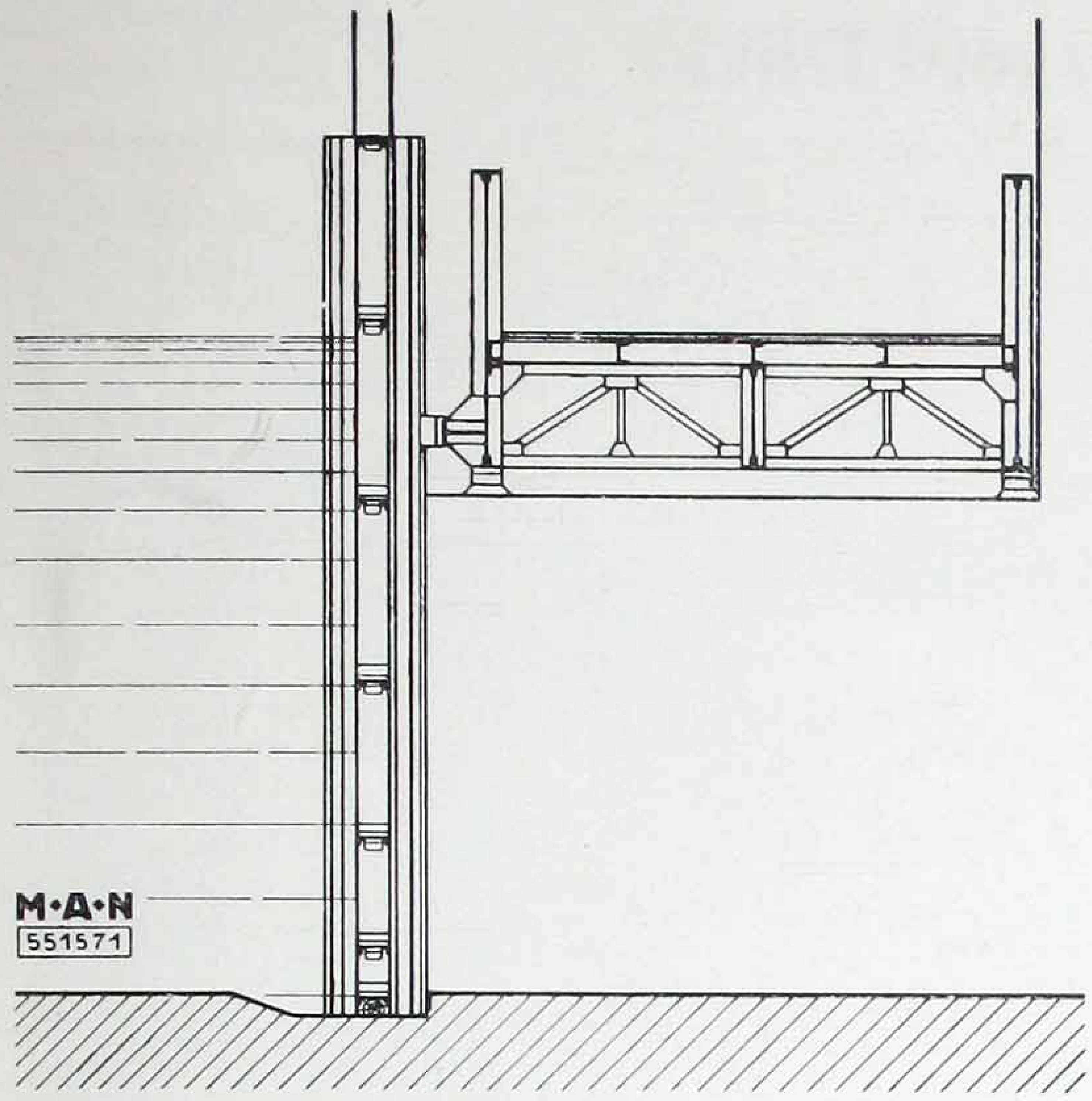


Fig. 49. Needle weir with floating needle support.

Needle Dams

with trestles, arranged to turn down on to the bottom, are suitable emergency closures for large spans. In the case of very large openings, the upper needle support takes the form of a pontoon which is floated into any opening to be closed and contains the necessary needles and boards.

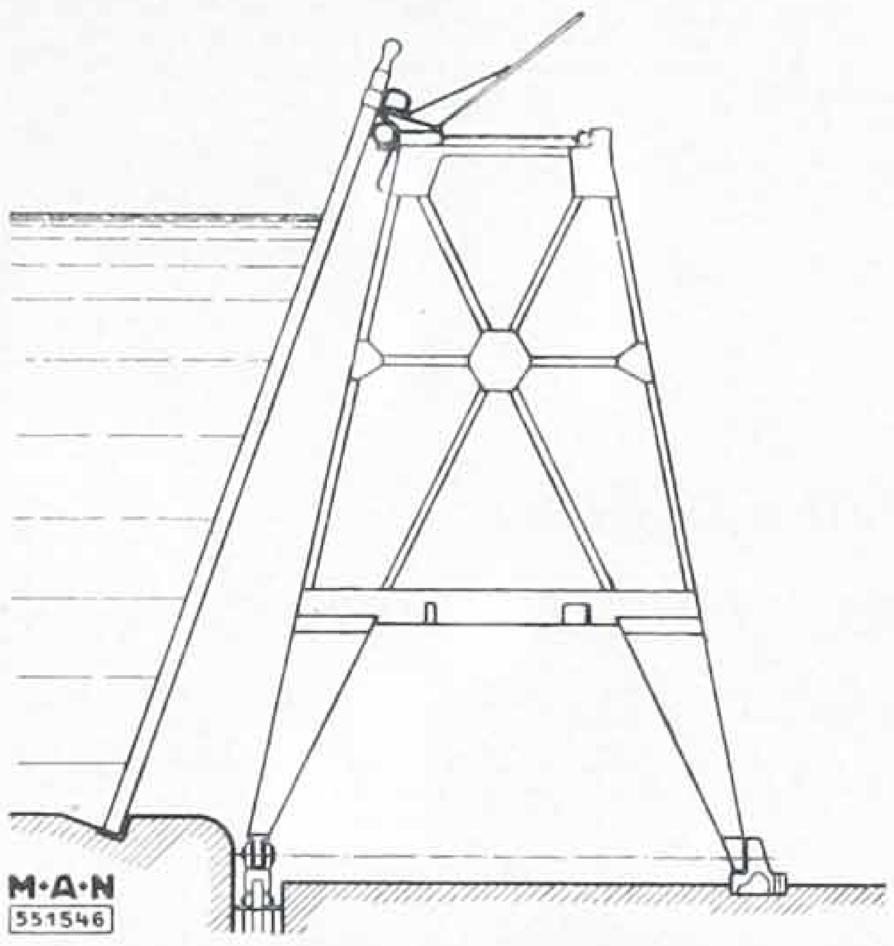


Fig. 50. Needle weir with filting trestles.

Fig. 51. Trash racke with cleaner at the Finsing power station, Middle Isar Co. (Bavaria).

Grating Clearing Machines.

The machines serve for the removal of drift from power station intake gratings and are electrically driven. The material discharged from the machine falls automatically into a truck.

Lock Gates and Docks.

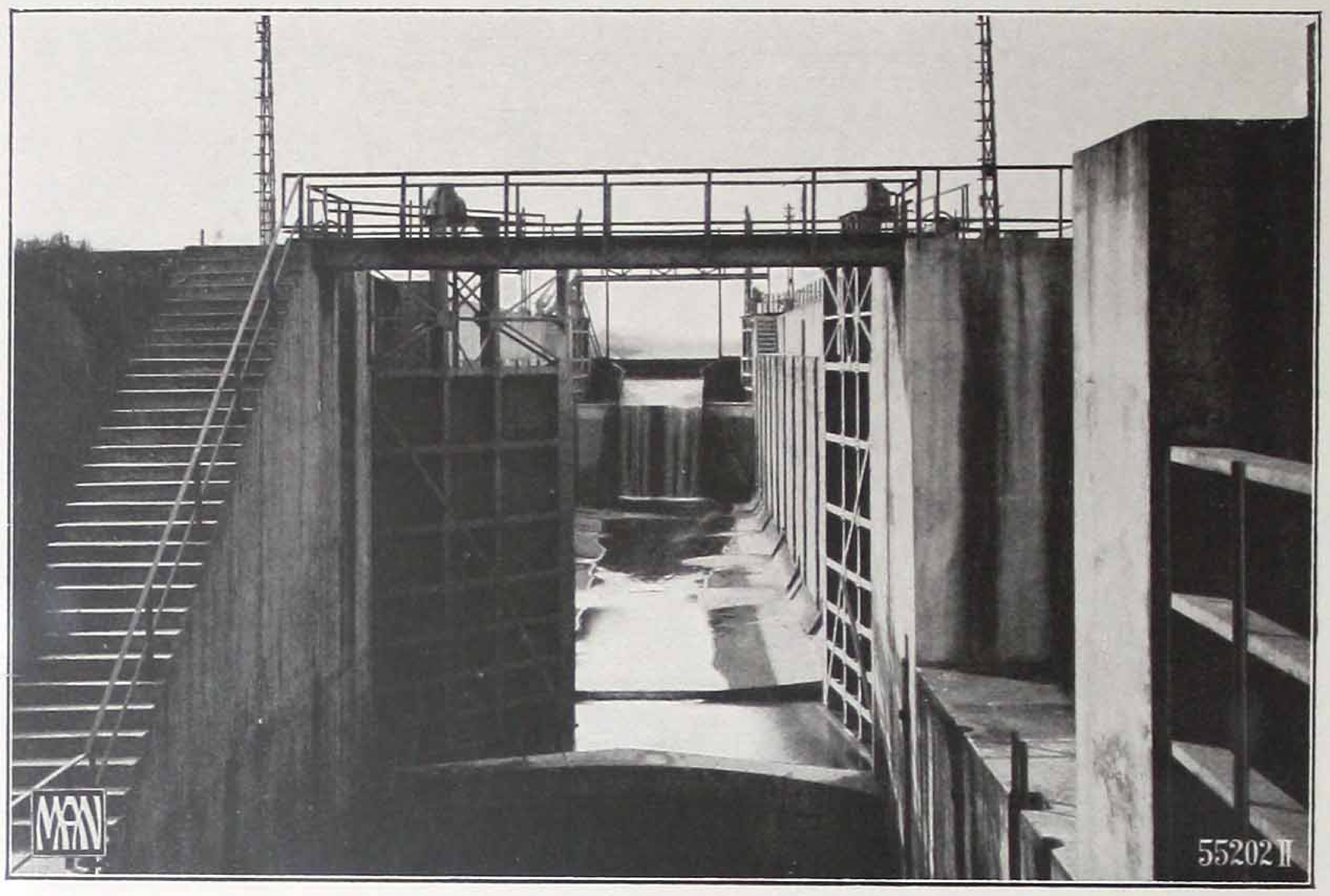


Fig. 52.
Lock gate in the Lech river near Gersthofen (Bavaria).

Mitre Gates

are employed for locks on inland canals. Their faces, of steel plates, may be flat or slightly curved. They are operated either by hand or electrically with centralised control. They can also be operated entirely automatically from the lock attendant's room.

Fig. 53
Lock gate in the Main river near Okriftel (Hesse-Nassau).

Sliding Gates,

which can take the water pressure from both sides, find application for large locks, sea locks and dry docks. They are arranged to travel back into recesses in the side walls on runners or rollers, damage from in-coming and out-going ships thus being avoided. Ballast tanks, which can be filled with water, are provided.

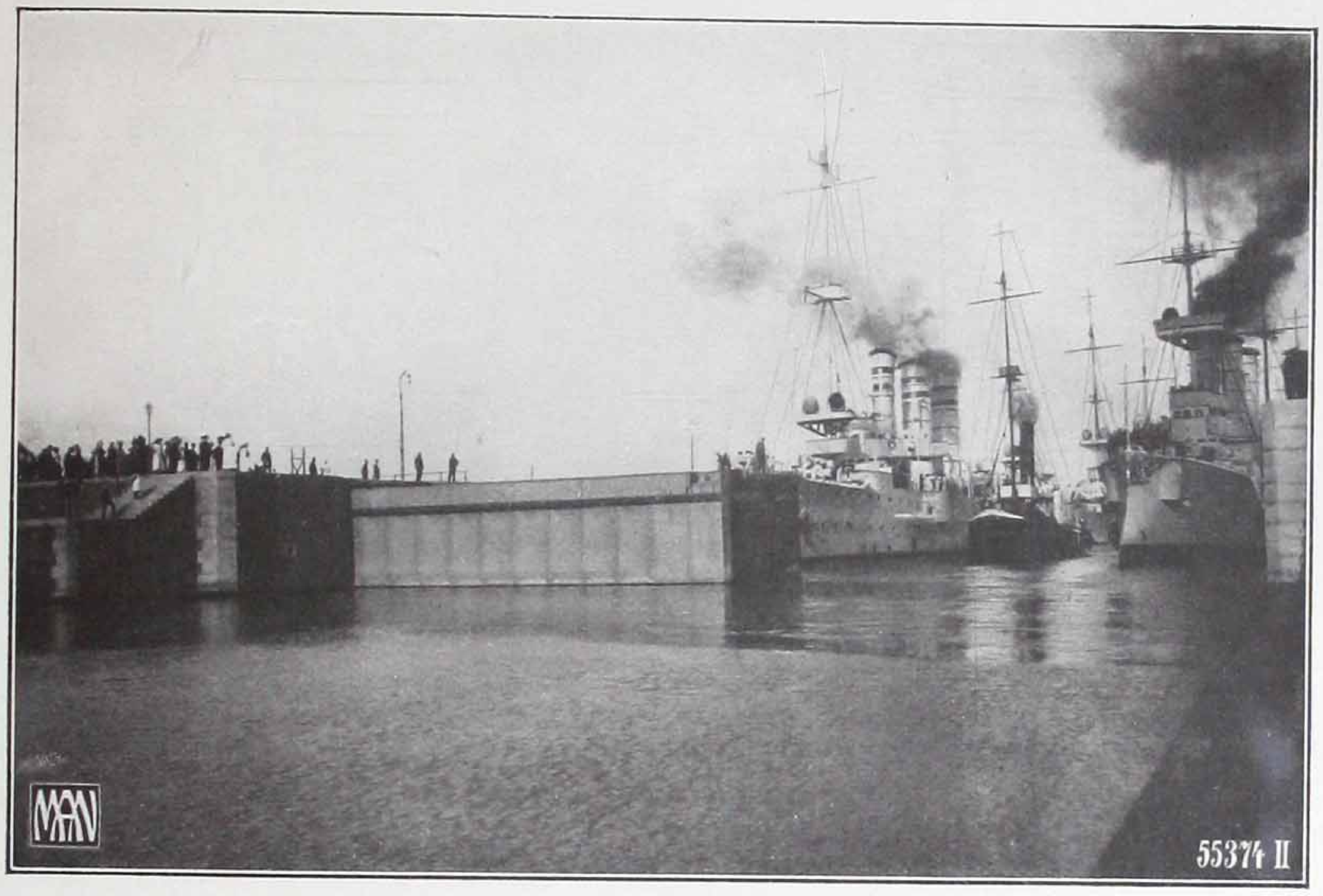


Fig. 54. Sliding gate for the sea lock near Emden (Northsea), being withdrawn into the recess.

Floating Gates

are also employed for dry dock closure. While sliding gates or are carried upon two timber runners or rollers, whereon they travel into the gate berths, floating gates are, as their name implies, floated with the aid of tug or capstan into the dock entrance and lowered into position by the admission of water into the ballast tanks.

The number of mitre gates, sliding and floating gates constructed by the M. A. N. up to do date totals 92.

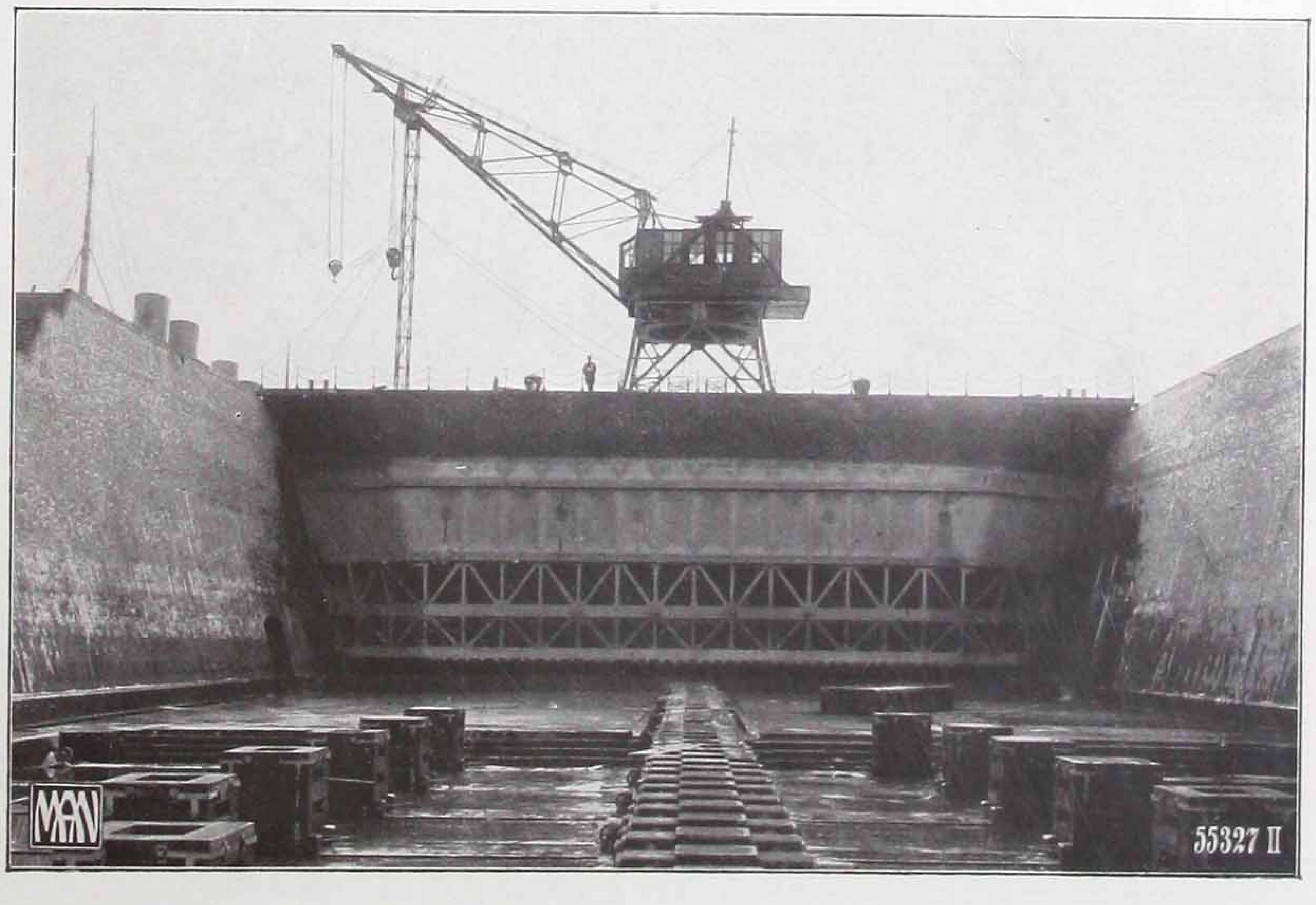


Fig 55. Floating gate for the dry dock at Bremerhaven, with revolving crane of $7^1/_2$ to 25 tons loading capacity at 59 ft. (18) to 31 ft. 11 in. (9,7 m) radius. Weight of the doors including ballast about 880 tons.

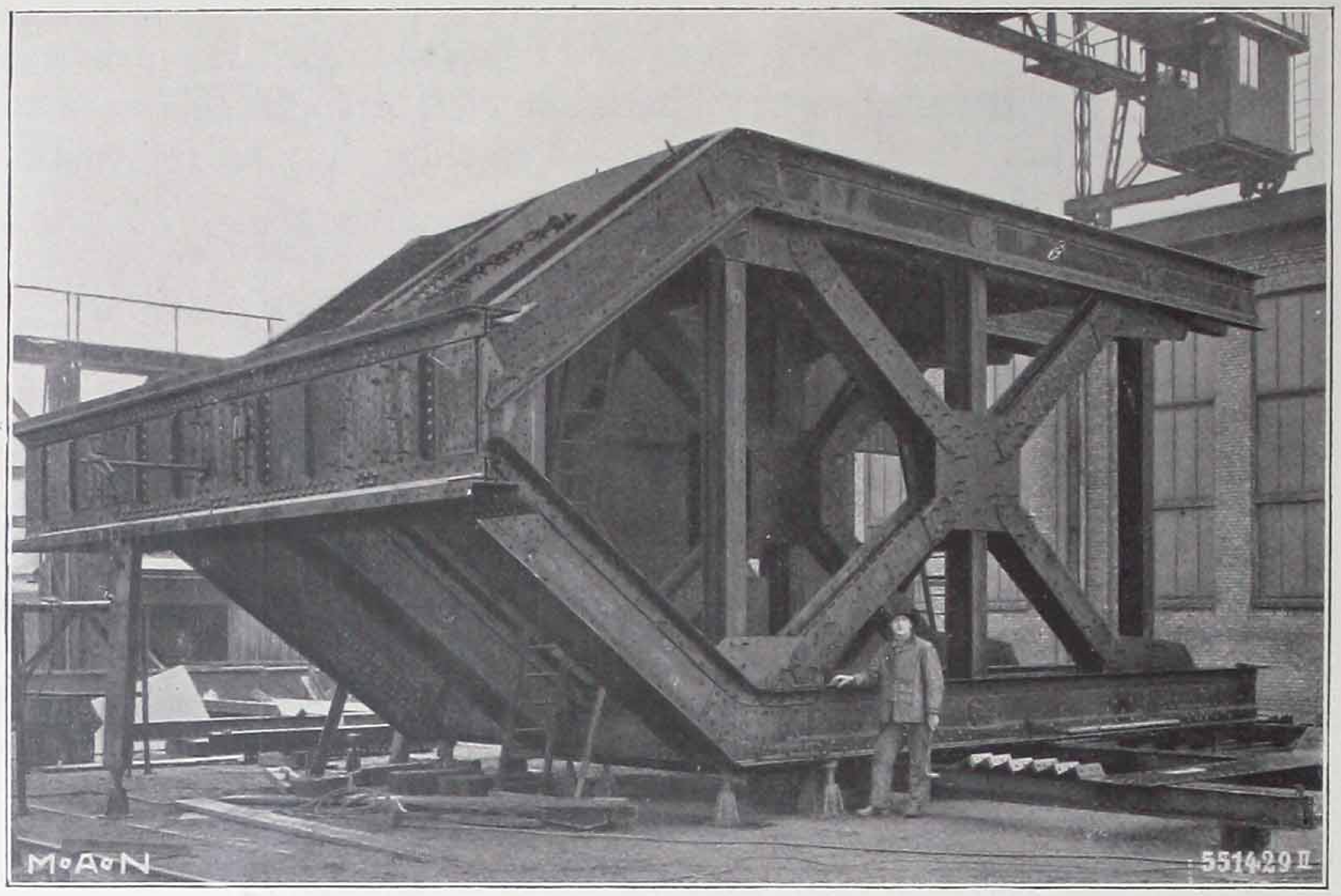


Fig. 56.
Floating gate for Rio de Janeiro Harbour (Brazil).

Compressed Air Foundation Work.

The construction of bridge- and weir piers at great depths necessitates the employment of compressed air. The M.A.N. manufacture the required equipment, such as compressed air caissons and hoisting gear with the necessary shaft cylinders and air piping. Owing to the amount of compressed air plant that they have supplied to various contractors, and the difficult foundation jobs they have executed in many countries, the M.A.N. have acquired very extensive experience in this branch.

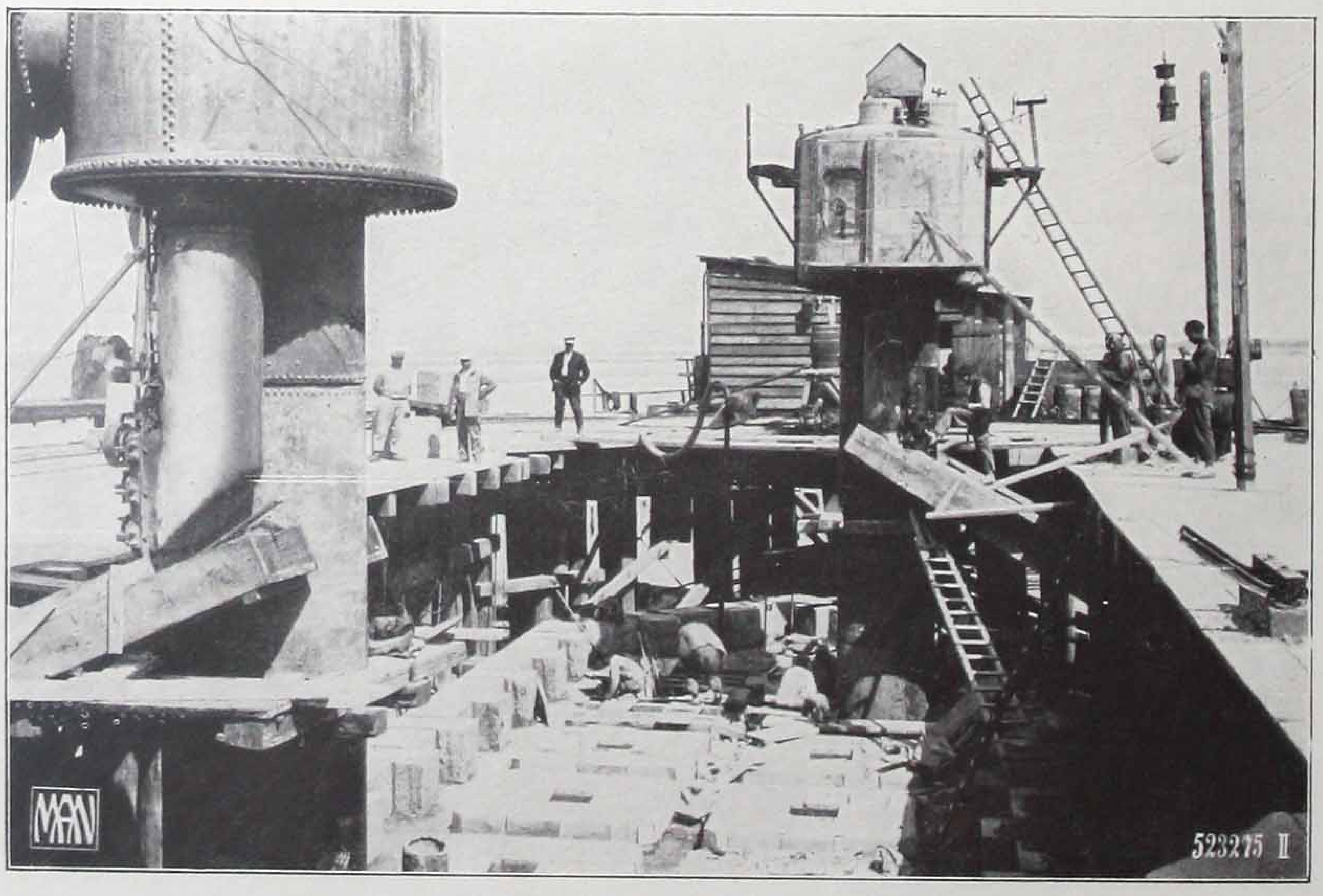


Fig. 57.
Hoangho-bridge (China). Erection of the two outer pillars of the bridge, using compressed air and pile foundation.

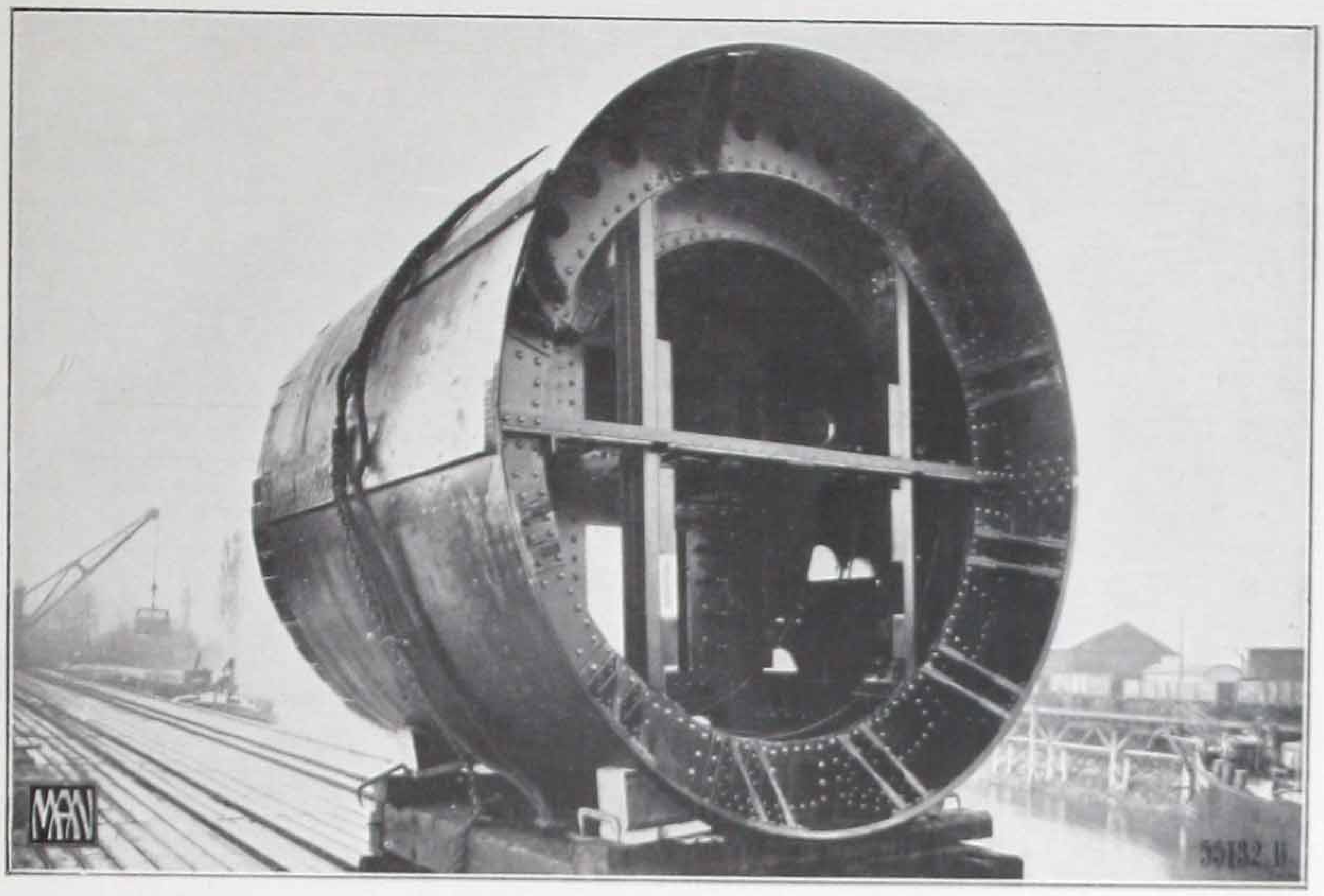


Fig. 58. Driving shield for tunnel constrution.

Driving Shields,

either with or without the use of compressed air, are required for driving under-water tunnels or tunnels in water-bearing or loose strata.

High Pressure Delivery Piping for Hydro-Electric Stations

is supplied by the M.A.N. in the form of rivetted pipes up to the largest dimensions employed. Such piping has already been produced up to 6 m. (approx. 19 ft. $8^1/_2$ in.) diameter, including the necessary extension pieces and anchorages.

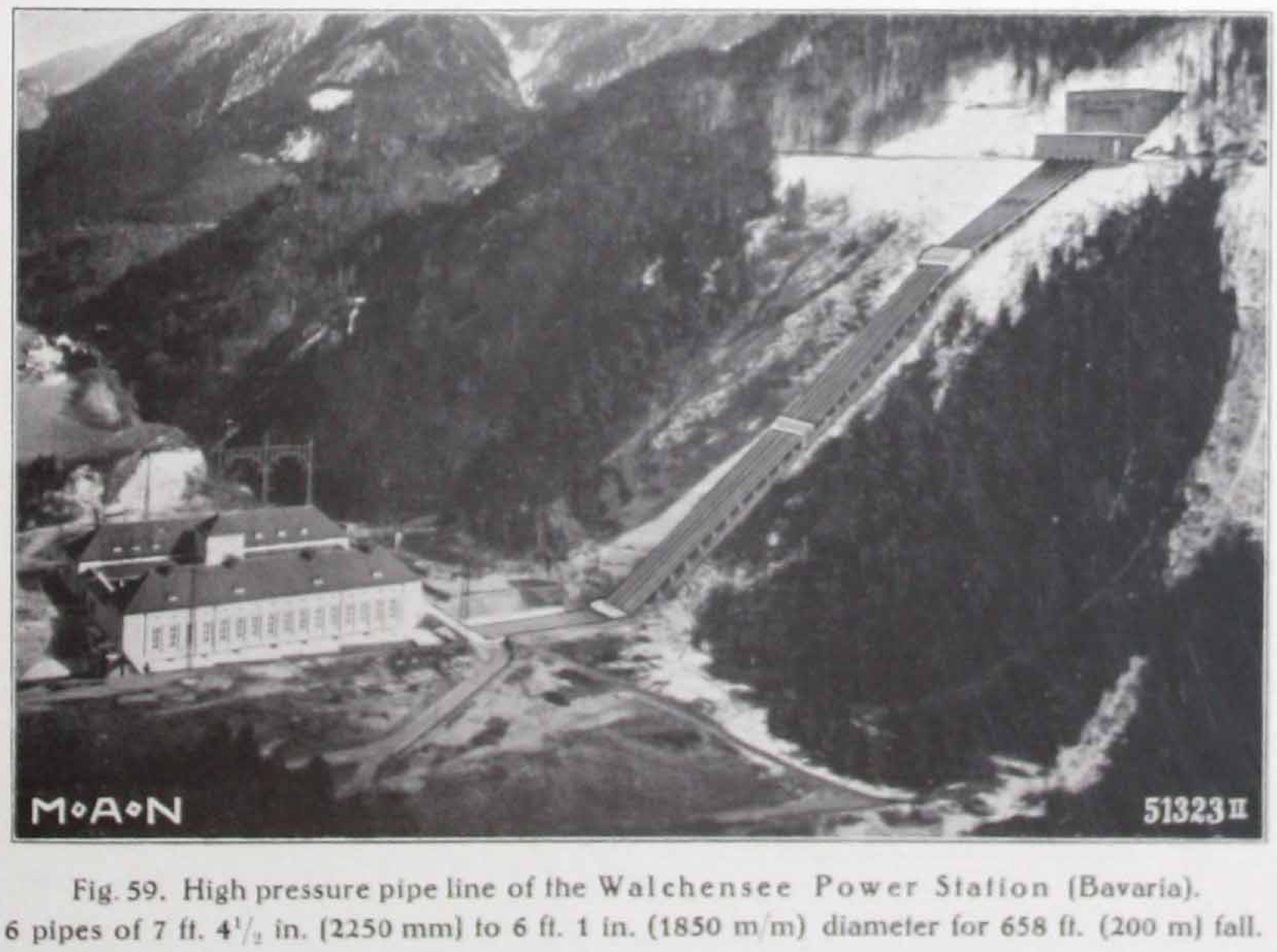


Fig. 59. High pressure pipe line of the Walchensee Power Station (Bavaria).
6 pipes of 7 ft. $4^1/_2$ in. (2250 mm) to 6 ft. 1 in. (1850 m/m) diameter for 658 ft. (200 m) fall.

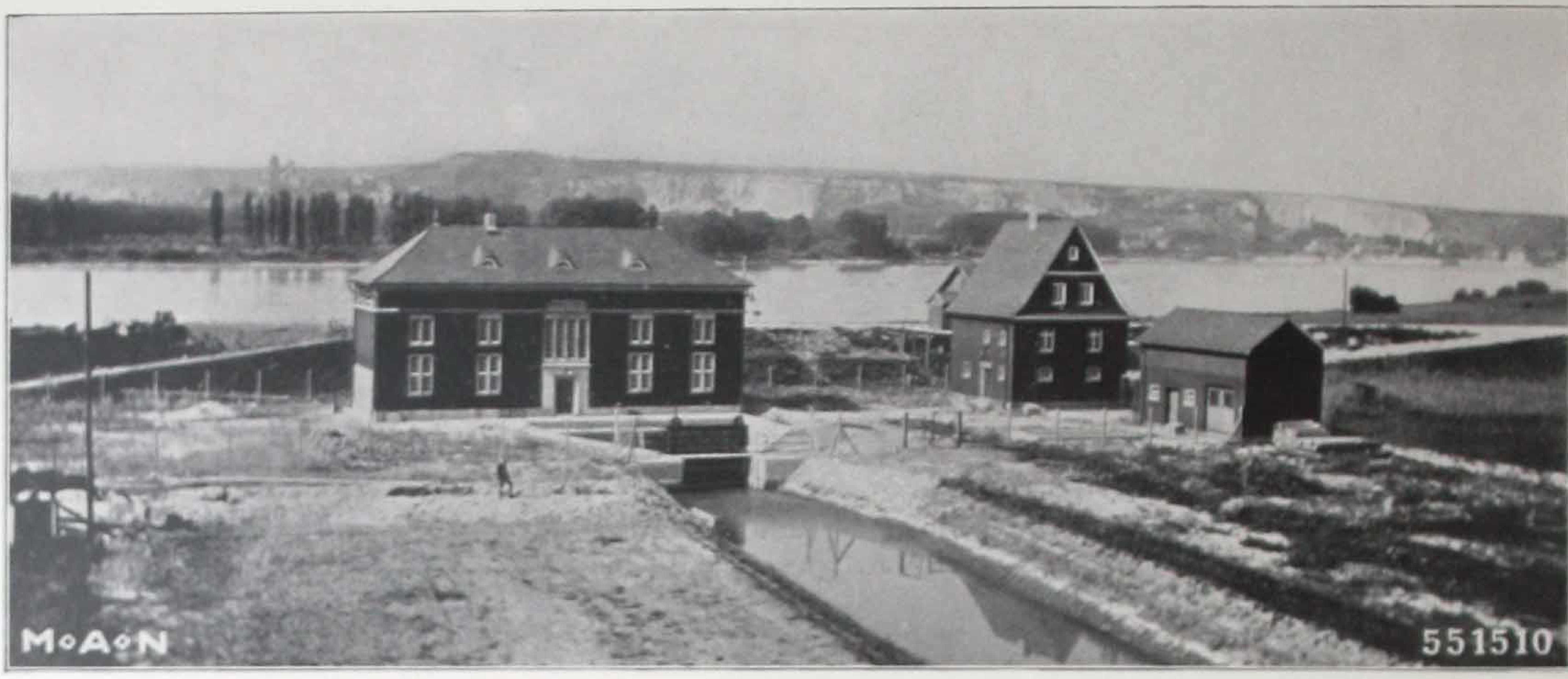


Fig. 60. Watering station Wächterstadt a. Rhein, Agricultural Department Darmstadt. Engine plant: 2 M. A. N. propeller pumps, output 220 gallons p. sec., 585 revolutions p. min., 70 B. H. P. 11 ft. 6 in. (3,5 m) head; 1 M. A. N. propeller pump, output 110 gallons p. sec., 720 revolutions p. min., 38 B. H. P., 11 ft. 6 in. (3,5 m) head.

Propeller Pumps

are very simple pumps for the raising of large quantities of water against small heads and is particularly adapted to the drainage of low-lying country, the handling of sewage etc.

The large diameter of the passages in this pumps enables water containing sludge, reeds, and other solid matter to be handled without difficulty.

The propeller pump is built for capacities of up to 6 cu. m. (1320 gallons) water per sec. and against heads of up to 8 m. (26 ft. 3 in.). It is placed in the tail water, is at all times ready for service and can be coupled direct to an electric motor or Diesel engine. The simple design and unobstructed passages result in an efficiency of up to 80 per cent. These pumps are so reliable that the most isolated plants can be operated by float controlled switches.

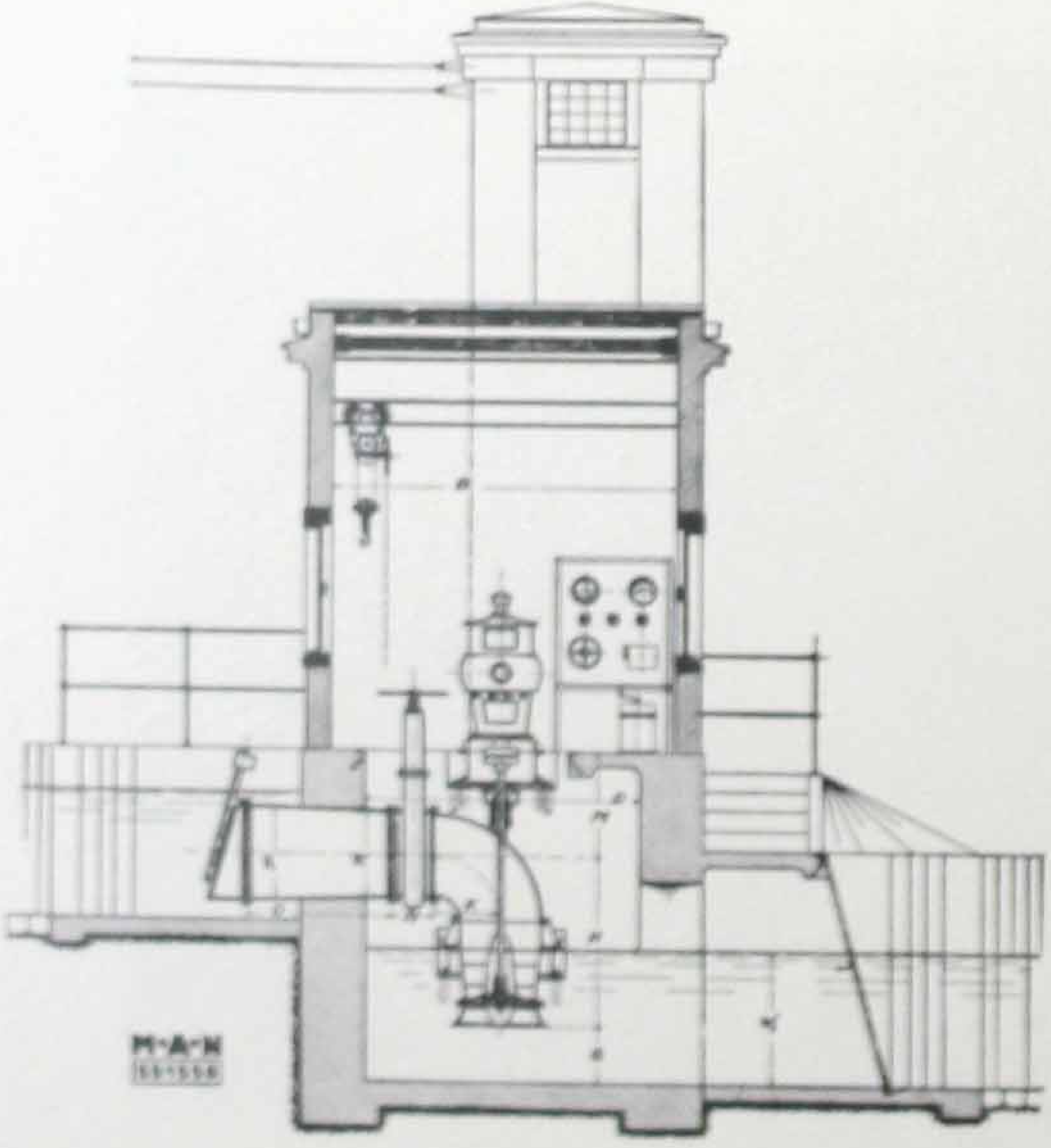


Fig. 61. Pumps works with M. A. N. propeller pump driven by vertical electric motor.